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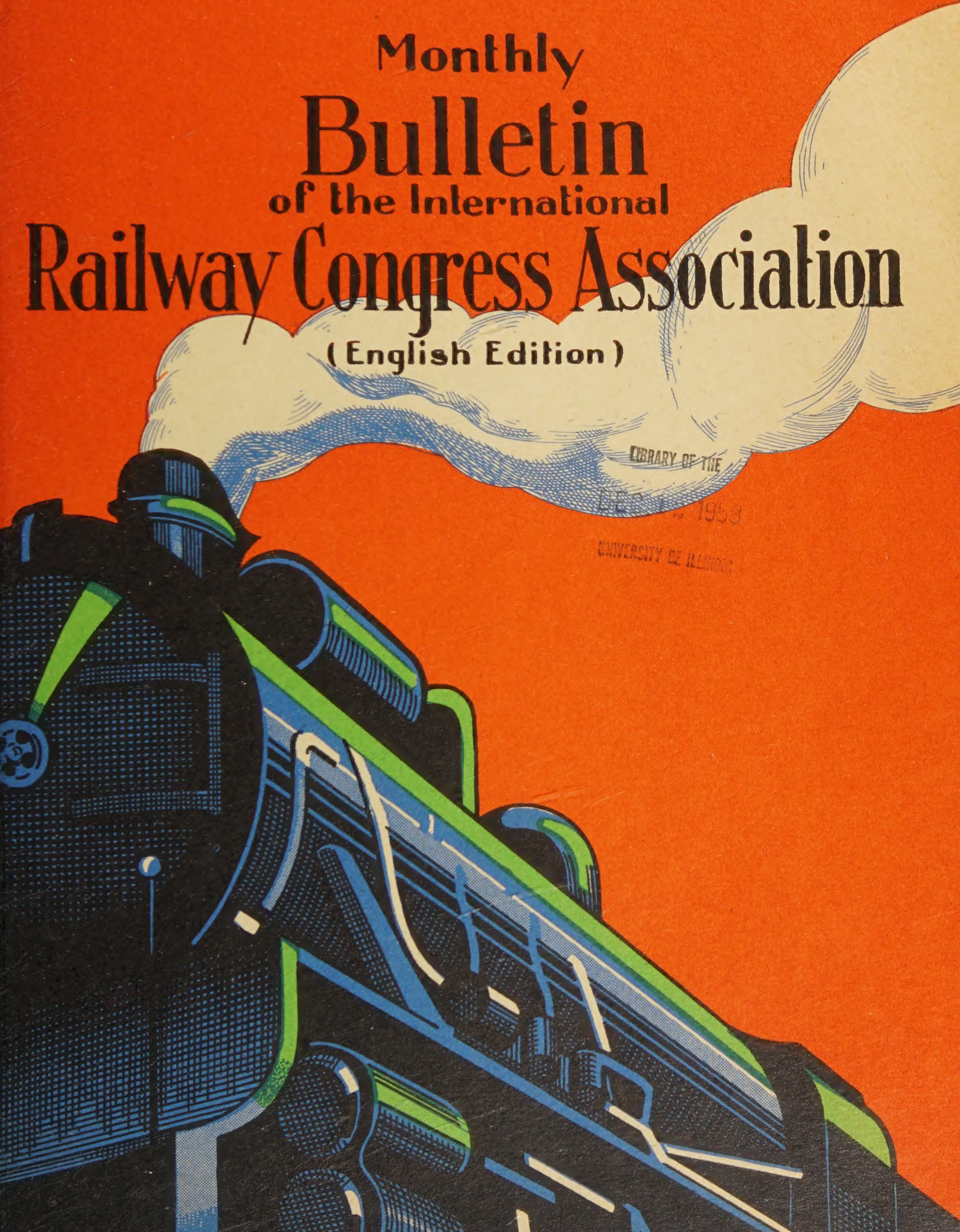

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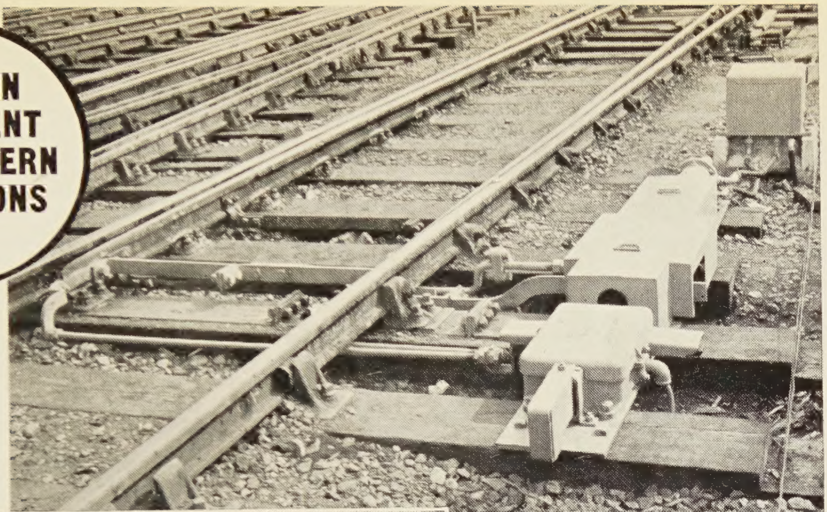

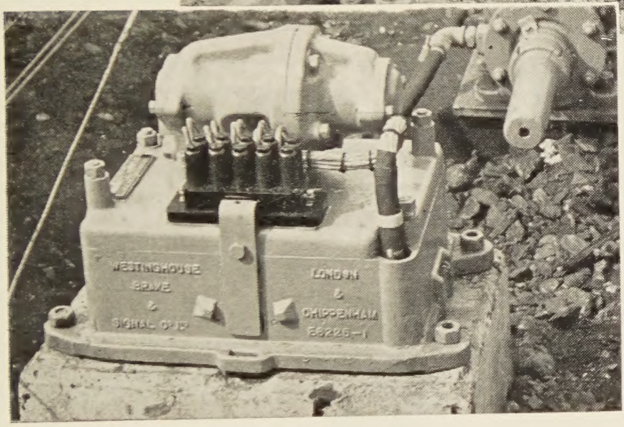

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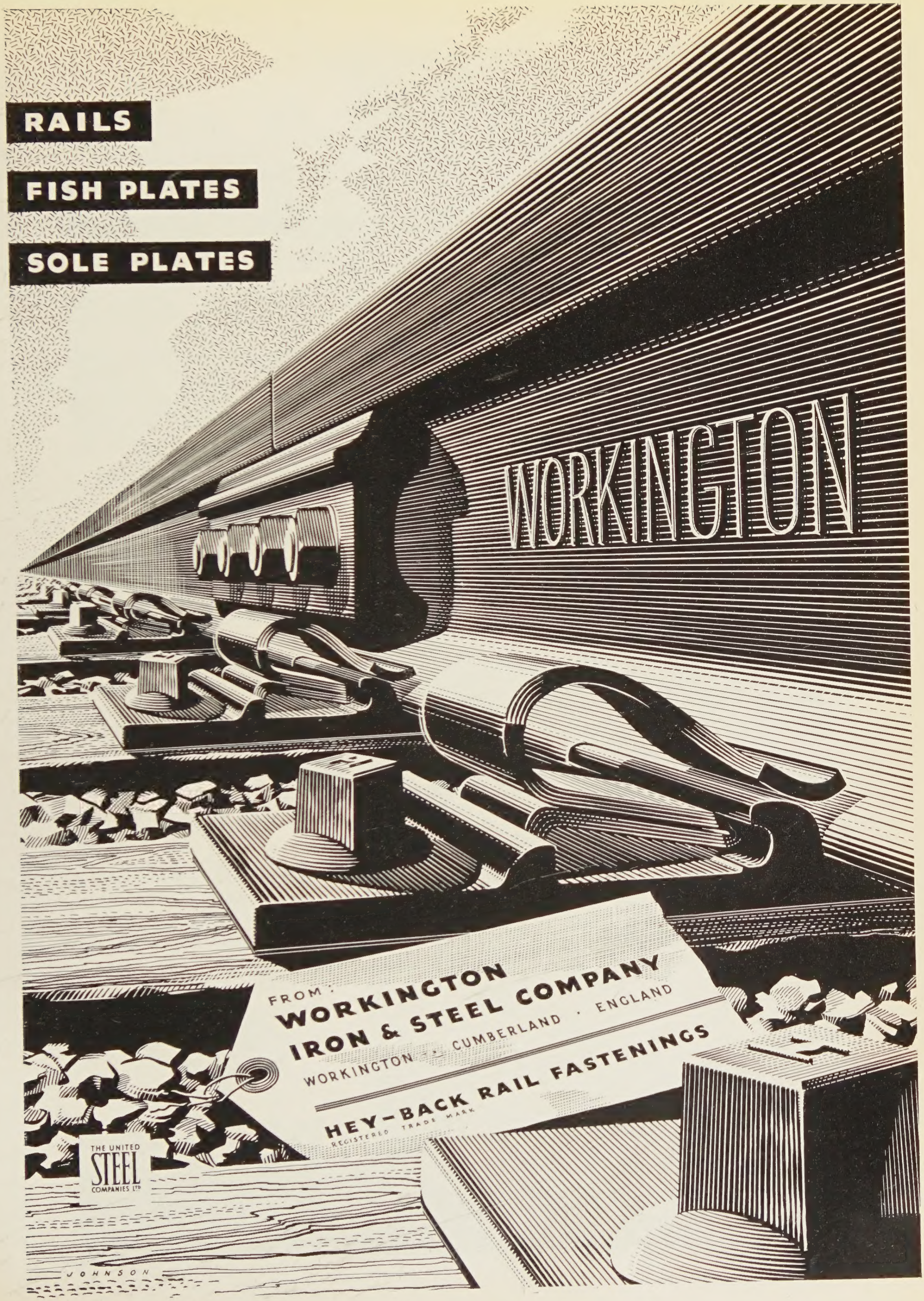

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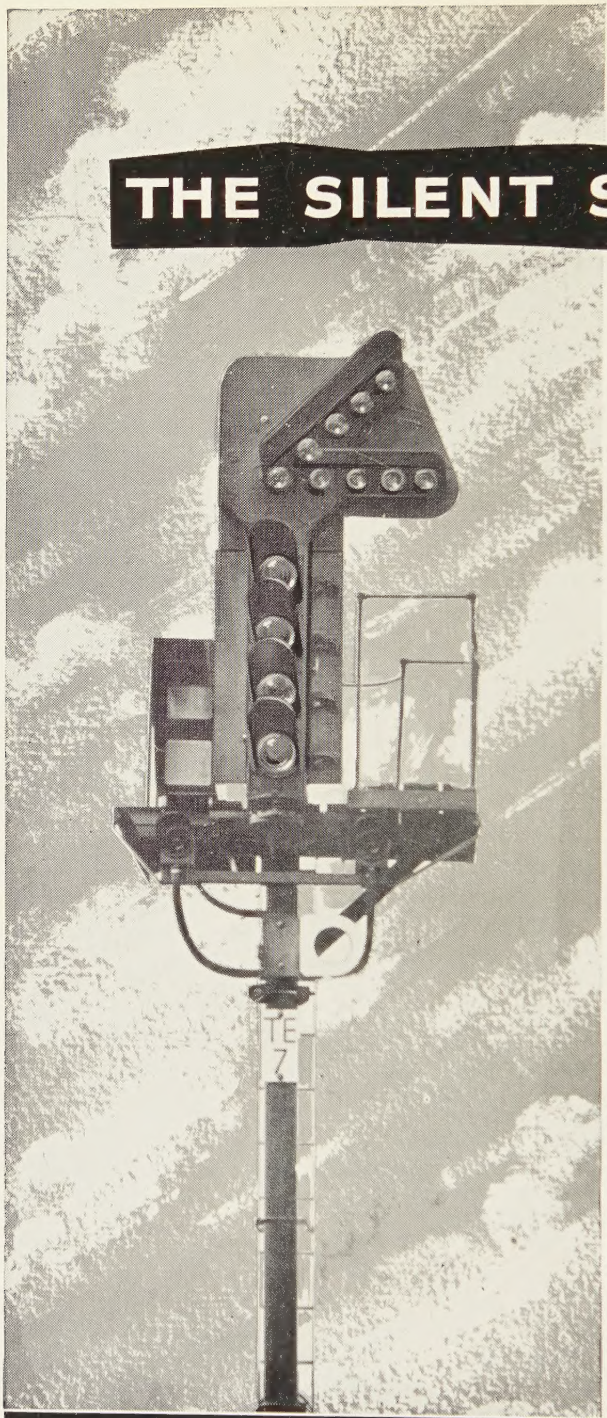

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BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
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(ENGLISH EDITION)

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Sleeper wear at rail or baseplate supports when using softwood sleepers,

by Lennart Borup,
Permanent Way Engineer, Swedish State Railways.

General viewpoints.

Of the different ways in which sleepers age the wear at the point of contact between the rail or the baseplate and the sleeper has a marked effect on the life of the sleeper. This wear is due to several factors, both independent and interdependent. This wear may be classified as a simple mechanical phenomenon, although there are many contributory causes unaffected by the load. Examples of these latter are decomposition caused by fungi and iron salts.

Wear at the rail or the baseplate supports is one of the factors which can be determinant for the life of a sleeper on the track. Excessive wear under the rail and the baseplate can be both a direct and an indirect reason for replacing the sleeper. If we allow that, under normal circumstances, 60-70 % of the wheel pressure is transferred to the individual sleeper, the load per rail support at an axle load of 17 tons is 5 - 5.5 tons. Moreover, there is the load from nearby axles, dynamic additions, etc. The area of the sleeper absorbing this load differs at the Swedish State Railways from $30 \times 17 = 510$ cm² in the case of a baseplate secured with elastic spikes to less than half of this area when no baseplate is used. This corresponds to a surface pressure varying from 10 to 20 kg/cm². By way of comparison it may be mentioned that current Swedish regulations allow for a permitted strain perpendicular to grain of 20 kg/cm² in the case of pine used indoors. As regards constructions used outdoors, in respect of which a higher moisture content must be allowed for, a 50 % reduction is often applied, i.e., a permitted strain of 10 kg/cm². Consequently, the strain on a pine sleeper is very high. Even when using elastic spikes with their relatively large baseplate, the « permitted strain » is exceeded.

In view of the large specific load involved with rail fastenings it may be of interest to examine the influence of the various factors on the rate of wear. It is known that increasing the area of support by inserting a baseplate reduces the wear. Basing our assumption on the difference in support area, all other factors remaining unchanged, the wear ought to be twice as large in the case of tracks without baseplates as those with baseplates.

If we wish to analyse the speed at which the baseplate or the rail works down into the sleeper under various service conditions we find that there are many other contributory factors. The wear on the sleeper under the rail and the baseplate may be regarded as a function of several additional factors. Broadly speaking, they can be divided into the following main groups :

1. The nature of the ground (foundations);
2. The type of ballast and its condition;
3. The type of sleeper and its condition (dimensions, age, quality of wood, etc.);
4. Type of rail fastening;
5. Type of rail;
6. The position of the sleeper on the track (straight track, curve, at a joint or by the rail bearing, etc.);

7. Condition of the track from the point of view of elevation, cant;
8. The weight of traffic on the track per time unit;
9. The type of trains used on the track and their condition.

The nature and application of the investigation.

In order to study in greater detail the wear on sleepers at the rail or the baseplate supports a large-scale investigation into the condition of sleepers as exhibited under various circumstances has been carried out at the Swedish State Railways. One of the factors studied was the extent of the wear at the two supports of the sleeper. The investigation made allowance for three different types of climatic condition, i.e., west coast, east coast and inland in southern Sweden. A total of 3 500 sleepers were examined on the track. None of the sleepers lay in a curved section of the track, nor were any of them at joints. The reason for excluding these two latter categories was to eliminate the influence of the extra wear that invariably occurs on sleepers located on curves and at joints and thus obtain sure results.

As regards ballast, tracks based on both gravel and macadam ballast were examined. The macadam ballast was Class 1, size 30-60 mm. Different types of rail and fastenings were included. Most of the sleepers were on tracks using rails of the 1896 model. The remainder supported rails of the 1924 model and, in addition, a type used on some private railways (32 kg/metre) was examined. The main data for the rails involved in the investigation are shown in Table 1.

Three different types of fastening were examined. Fastenings using ordinary spikes with and without baseplates were the most prevalent. This is, of course, natural in that the system involving ordinary rail spikes is the one most generally used on the Swedish State Railways network. In addition, there were cases of rails secured with elastic spikes. When using these latter the dimensions of the baseplate are 300 × 170 mm as compared with the 280 × 170 mm used with ordinary rail spikes. The number of elastic spikes per baseplate is 6, but in the case of ordinary rail spikes the number varied between 4 and 6 per sleeper.

TABLE 1. — **Main data in respect of the rails involved in the investigation.**

Model	Weight kg m	Total height mm	Foot width mm	Moment of inertia cm⁴
1924	43.2	133	133	1 310
1896	41.18	133	133	1 270
Private railway model	32	123	123	873

Most of the sleepers used on the Swedish State Railways are of softwood, pine (Pinus silvestris) of Swedish origin, and consequently the investigation referred only to pine sleepers. The length of the sleepers investigated was 270 cm and the thickness 16 cm. The width, however, varies. This is due to the employment of both two and four saw-cut sleepers being used. The average maximum width of the sleepers investigated was 24 cm.

The investigation has referred solely to impregnated sleepers; it being earlier practice to mark these with the date when laying. It should be pointed out, however, that impregnated sleepers have mainly been in the minority on the sections under review. Up to 1940 the main preservative used was creosote oil, except during the period

1912-21 when salt preservatives were employed. However, sleepers impregnated during this latter period are rarely encountered nowadays on Swedish tracks. During the period 1940-50 salt impregnation predominated (The Boliden salt, BIS with chromium and zinc arsenates as preserving agents) but, since 1950, only creosote oil has been used. As regards the method of impregnation with creosote-oil, up to 1910 full-cell process was the practice and, since that date, Rüping empty-cell process. The salt impregnation was effected by vacuum and pressure according to the full-cell treatment. Both creosote-oil and salt-preservative impregnated sleepers were examined. It was not possible to examine the wear on non-impregnated sleepers since these were not dated when laid and, furthermore, there would have been no point in doing so since only impregnated sleepers are used nowadays.

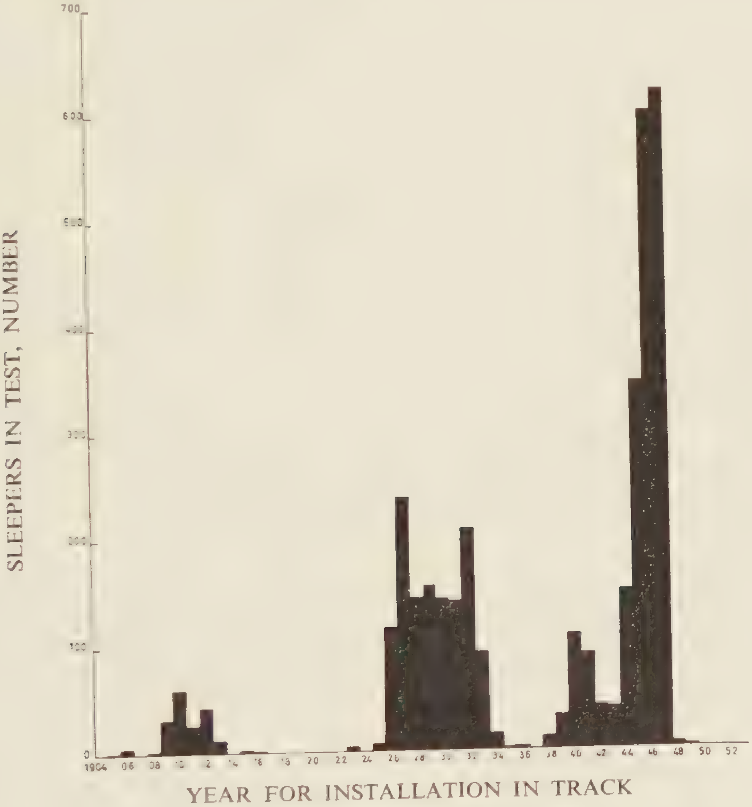


Fig. 1. — Distribution of sleepers in accordance with year of laying.

For several reasons it is always impossible in an investigation of this nature to have the material equally divided into, for example, time in track and the total traffic load per time unit. Naturally, from the point of view of investigation it is interesting to be able to study the wear as related to both the age of the sleeper and the load to which it has been exposed. The desired division of the material is complicated mainly by the fact that the number of impregnated sleepers laid on the Swedish

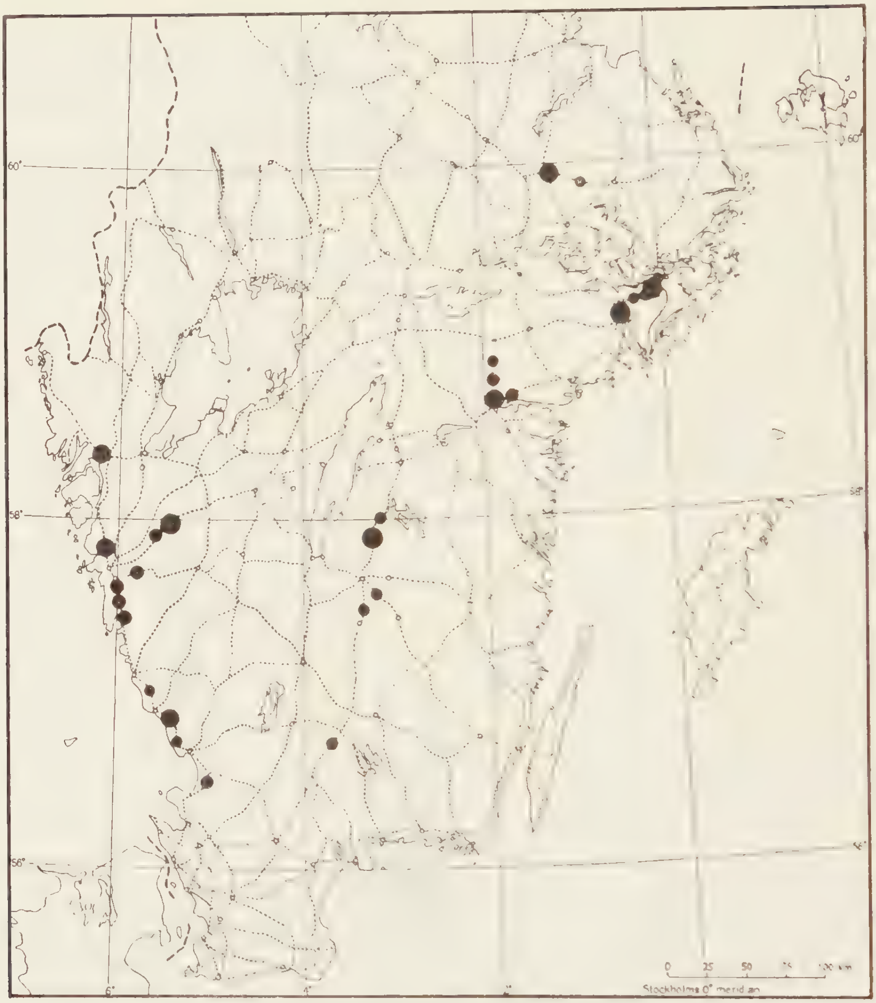


Fig. 2. — Geographical distribution of the examined sleepers.

State Railways has been irregular. A changeover to the laying of exclusively impregnated sleepers was not made until 1953. The sleepers investigated fell mainly into two age groups, i.e., those 8-10 years old and sleepers ready for replacement. The age distribution of the sleepers examined is shown in figure 1.

The division of the sleepers vis-à-vis tracks and climatic conditions is shown in figure 2. The size of the marking circles is directly proportional to the number of sleepers examined on the respective subsections.

Processing of the material.

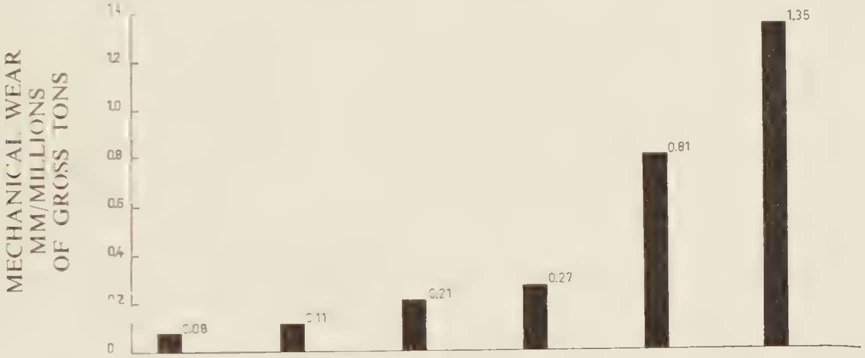
Of the previously mentioned factors affecting sleeper wear, the type of ballast and the type of rail fastening attract the greatest interest. The investigation was so arranged that the wear down could be related to both the age of the sleeper and the load; the differences occurring with various types of ballast and fastening also being considered.

Examination of the material to determine the wear down as related to the time the sleeper had been on the track has however not given any definite results. This is due to the fact that, inter alia, the traffic intensity varied greatly on the sectors examined. Of greater interest are the results of the statistical processing of the material concerning the relation between wear and train load. Sleepers which have been subject to the same total train load can differ greatly in age. Here, the total load of a sleeper is the addition of all the loads, including that of locomotives, that have passed over the sleeper since the time that it was laid. The information has been taken from the existent load statistics for various sections of the line. The material extracted from these statistics has been adjusted to include the locomotive and also solely for the stretch of track on which test sleepers were included. For these groups calculations have been made in respect of the wear in mm per train load in gross tons × 10^6. The standard deviation for each group has also been calculated. The standard deviation has been calculated in accordance with the following formula :

$$s^2 = \frac{\Sigma(x_i - \bar{x})^2}{n - 1};$$

in which x_i is the variable's individual values, $\bar{x}$ their average and n the number of observations. As has been mentioned, the material is unevenly divided as regards the age-factor that must be allowed for when dividing the load and ballast/fastening groups. The results obtained in respect of the wear for the six ballast/fastening groups are shown graphically in figure 3 and also in Table 2.

There is a marked difference between the groups at the 0.1 % significance level. The values obtained give a clear indication of the effect of the various factors (ballast,



Group . . .	1	2	3	4	5	6
Fastening. .	Elastic spike baseplate	Cut spike baseplate	Cut spike	Cut spike baseplate	Cut spike	Cut spike
Ballast . . .	Stone ballast	Stone ballast	Stone ballast	Gravel ballast	Gravel ballast	Gravel ballast
Rail	Model 1924 43.2 kg/m	Model 1896 41.18 kg/m	Model 1896 41.18 kg/m	Model 1896 41.18 kg/m	Model 1896 41.18 kg/m	Private railway model 32 kg/m

Fig. 3. — Wear rate for various ballast/fastening groups.

TABLE 2.

Summary of the wear-rate values for the various groups and the calculated standard deviation of the average value.

Group					Wear rate in mm per gross ton load × 10^6		Number of test sleepers in group
No.	Ballast	Spikes	Baseplate	Rails	Average value $\bar{x}$	Standard deviation s	
1	macadam	elastic spike	baseplate	1924	0.08	0.02	200
2	macadam	rail spike	baseplate	1896	0.11	0.06	751
3	macadam	rail spike	—	1896	0.21	0.09	100
4	gravel	rail spike	baseplate	1896	0.27	0.13	2 000
5	gravel	rail spike	—	1896	0.81	0.49	349
6	gravel	rail spike	—	32 kg/m	1.35	0.67	100

type of fastening and type of rail) on the rate of wear. The differences between the different wear rates is surprisingly large. Even if we disregard the tracks with thin rails (group 6) the difference between the extreme values is large. The rate of wear is no less than 10 times greater for group 5 than for group 1. The difference may be ascribed to the superior design of the fastening, ballast, more even condition of the sleepers and better track position of the first group.

Sleeper quality and track position.

When assessing the extent of the wear rates it must be remembered that the sleepers on the stretches of track on which the investigation was carried out are continually being changed. A partial exception to this rule are the sleepers in group 1 which, for the most, are confined to a few age groups. In both groups 1 and 2 the ballast consists of macadam and the fastening of baseplates. The difference lies in the larger baseplate in group 1 (elastic spike fastening) and the elastic grip on the rail of these spikes. This naturally means that the wear should be less in group 1 than in group 2. However, the whole difference in wear rate of 0.03 mm per gross ton load × 10^6 cannot be explained by the different design of fastening alone. There is no doubt but that the more even condition of the sleepers in group 1 as compared with group 2 has also had its influence. Had the whole investigation been carried out on stretches of track on which the sleepers had been of uniform age it is certain that the rate of wear would have been less than is indicated by the values obtained. There is no doubt that the wear rate also depends to some extent on the position of the track. If the track is uneven the weight of the rolling stock passing over the sleeper is unevenly distributed and, as a result, one particular sleeper may have to bear a greater load than its neighbour and thus suffer greater wear. This may also occur indirectly when the sleepers are of different ages in that an inferior sleeper « gives » more when subject to load and thus results in an uneven track position when loaded. The importance of an even sleeper quality is also clearly shown by the size of the standard deviation for the various groups. The lowest percentage standard deviation, 25 % of the mean value of the rate of wear, is in group 1. In the other groups, the standard deviation is in the region of about 50 % of the average values.

Rail fastening.

As mentioned earlier, the investigation was so arranged that the wear associated with different fastening systems could be compared. A comparison has been made between systems with and without baseplates and, in this connection, a direct comparison can be made between the results for groups 2-5. True, some of the older sleepers which, during the course of the investigation were found to be on tracks with baseplates and/or macadam ballast had previously been on tracks without baseplates and/or with gravel ballast. However, all that this means is that the difference in wear between the two types of fastening is less than it should be. The trend in this case has been towards the employment of both better fastening and better ballast. A direct comparison shows the wear rate on a macadam track to be almost twice as large with a fastening without baseplate as with one incorporating a baseplate. When gravel ballast is used this difference increases to 3 times in favour of the baseplate fastening.

Ballast.

An even greater difference in the rate of wear is noticeable when a comparison is made between the two types of ballast employed, i.e., macadam and gravel. On rails supported by baseplates the rate of wear is 2.5 times greater on gravel-ballast tracks than on macadam-ballast tracks. When no baseplate is used, and the specific surface pressure at the point of rail contact is consequently greater, the difference between gravel and macadam is even more marked, viz.: about 4. These figures clearly indicate the influence of the type of ballast on the rate of wear. The reason is that the elasticity of macadam is superior to that of gravel. It retains its elasticity all the year round, whereas gravel ballast freezes in the winter and becomes less resilient than macadam. Even under normal circumstances the forces acting on the sleeper are large. When the gravel ballast is frozen more or less solid the dynamic additional forces are at times of such a magnitude that the wood fractures. The wood cells in the actual supporting surface are compressed to breaking point while, at the same time, the fibres along the sides of the baseplate and the foot of the rail are cut off. When using gravel ballast there is also the fact that minute particles of gravel work into the space between the baseplate and the sleeper and between the sleeper and the rail and, when the rail and the baseplate are subject to movement, act as a grinder. From the point of view of drainage, too, gravel ballast is inferior to macadam. As a result, the sleeper is generally damper. Thus, a sleeper laid in macadam ballast is better able to withstand, or absorb, forces than the generally damper sleeper laid in gravel. The decrease of the compression strength perpendicular to grain is in the region of 30 % when the moisture content increases from 15 % to the fibre saturation point (moisture content = 28 %) and above.

Rails.

Most of the investigation was carried out on tracks where the rails were of the most commonly occurring type, i.e., the 1896 and 1924 models. Quite naturally, the stiffness of the rail influences the wear on the sleeper. A stiff rail divides the forces more than a weaker rail. In order to determine the influence of this factor the investigation included a small series of sleepers on tracks with thin rails (group 6). A comparison between groups 5 and 6 showed that the thinner rails resulted in the rate of wear being more than 1.6 times as great. The relation between the moment of inertia for both groups is 1 : 1.45. When making this comparison it must be remembered that the foot of the thinner rail is not as wide and that the difficulty in maintaining a good rail position with the 32 kg rail is greater than is the case with the thicker 1896 rail.

Climate.

It has also been possible to divide the material to some extent between the three climatic groups. Owing to the difficulty in obtaining comparable series it is hard to point to any differences between the climatic conditions examined. However, it may be said that the results point to there being a tendency for the rate of wear to increase in the west coast area.

Increase in the rate of wear.

When making an assessment of the wear to which the sleeper is subject it is a natural sequence of thought to regard this phenomenon as a function of the time that the sleeper has been in situ. As has been mentioned earlier, difficulty was experienced in arriving at a simple relationship between wear and age. On the other hand, a good correlation was obtained between the wear and the train load to which the sleeper

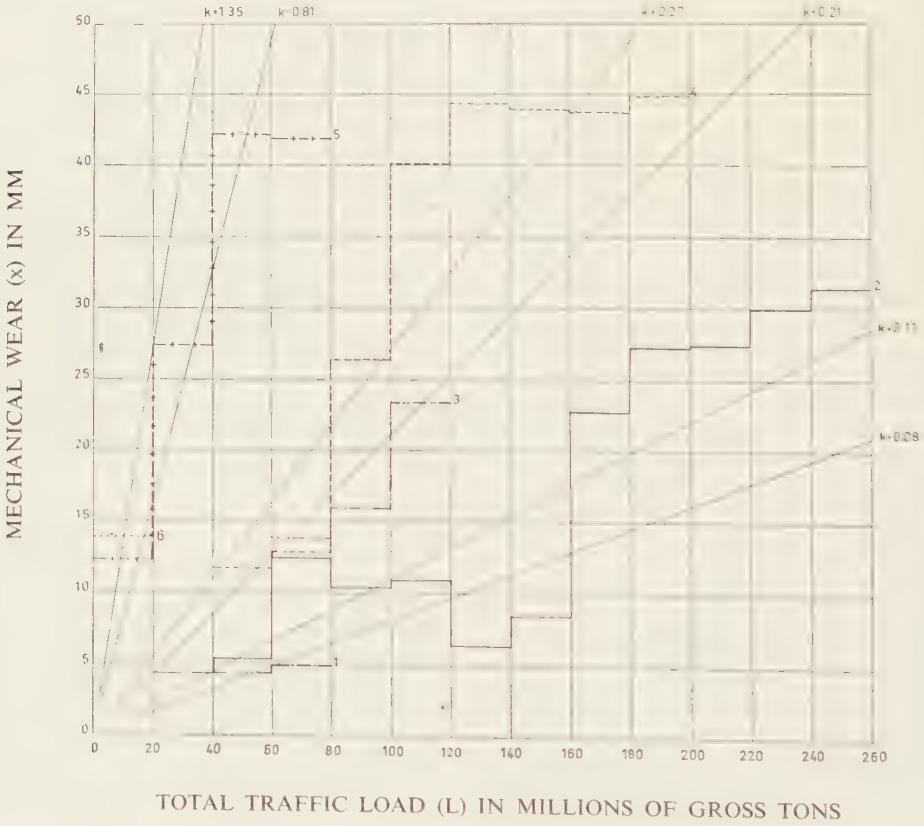


Fig. 4. — Increase in wear with increased total load on sleepers in the case of the six ballast/fastening groups examined.

had been subject. However, this condition is only applicable within the limits concerning vehicle weight, track erections, speeds, train frequency, etc., as encountered in normal railway operation.

The increase in wear with increasing total load has been studied in the case of the above-mentioned six different combinations of ballast and fastening. The results are shown in figure 4, where the wear within the various load groups are shown. This wear diagram also shows the theoretical wear lines of the type.

$x = k \times L$, where x is the wear in mm, L the total load in gross tons $\times 10^6$ and k a coefficient depending on the type of ballast and fastening. Thus the prerequisite is that the course is linear, a factor which does not completely correspond to actual conditions. The first phase of the action is partially a compression of the contact area of the sleeper during which process the baseplate assumes its correct position. This first pressing of the baseplate and the rail into the sleeper — which takes place very soon after the sleeper is laid on the track — is of such small dimensions that it has been disregarded in this connection. Of course, a certain variation from this theoretical action takes place during the latter part of the sleeper life when the rate of wear increases.

Conclusions.

The results of this investigation, that is as regards the wear on impregnated pine sleepers, can be summarised as follows :

1. The greater the uniformity of sleeper quality the less the wear; this being due to the associated more even elasticity in the individual sleepers. As a result, a well laid track contributes to reduced wear.

2. On both macadam and gravel ballast tracks the use of baseplates results in much less wear. The investigation shows a reduction of up to 1/2 with macadam ballast and up to 1/3 with gravel ballast.

3. As regards the wear on the sleeper under the baseplate and the rail foot, the elasticity properties of the ballast material are of great importance. The superior properties of macadam reduced the wear 2.5 and 4 times respectively with and without baseplates. To a certain extent this reduction in wear with macadam ballast is due to the better drainage properties.

4. Reduction in the stiffness of the rail increases sleeper wear. The investigation showed that, using gravel ballast, ordinary rail spikes and no baseplates, 32 kg rails resulted in a 60 % increase in wear compared with the 1896 model.

The only subject taken up to the discussion stage has been the wear on sleepers. As regards the value of using better fastening devices and replacing gravel ballast with macadam there are other aspects to the problem. Better fastening devices and, in particular, macadam instead of gravel, should reasonably result in less wear and tear on the rolling stock too. Macadam ballast, with its superior elasticity should, especially in winter, result in considerable advantages. Even though this aspect of the question has not been dealt with during the course of this investigation it should, nevertheless, not be forgotten since there is every indication that it is of great economic significance.

[656 .25]

Automation applied to railway operation by means of signal engineering,

by Dipl.-Ing. Karl Friedrich KÜMMELL,

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(*Die Bundesbahn*, No. 16, August 1957.)

At the conclusion of the last war, the Deutsche Bundesbahn instituted a programme of technical development which has greatly influenced the working of the traffic and will continue to do so on an increasing scale, namely the replacement of the mechanical and the conventional electric power signalling equipment, using mechanical and electro-mechanical interlocking, by purely electrical apparatus. This marks the first steps in an evolution noticeable on other European railway systems and also in North America, but is noteworthy for the great extent to which it has been applied on the Bundesbahn lines, and also the rapidity with which that has been effected. This has of course been facilitated by the fact that many installations were destroyed during hostilities, at which time well-tried methods which had given every satisfaction, had been in use over a long period of years.

This process was distinguished by tendencies of the same order as those seen in what has come to be called automation in industrial operations, much to the fore of recent years. This does not mean simply that the technical design of signalling installations shall undergo a certain amount of modification but that, at the same time, the methods of operating them, previously entirely manual in character, also shall become changed and be directed to realising an economy in staff by replacing increasingly the former actual operating duties by purely supervisory functions. In this matter the railways have the advantage over other branches of industry in that automation can be applied to the traffic working with the aid of the latest developments in signal engineering, over longer or shorter sections of route, as occasion serves, whereas an ordinary business concern is obliged to incur a considerable outlay and make far-reaching changes in its methods of working.

The first forms of automation in signalling and traffic working made their appearance about 30 years ago. In North America, under the pressure of rising wage costs, the railways found themselves obliged to place their intermediate stations on long lines, frequently carrying but little traffic, under remote control from a central point, by so-called C.T.C. equipment. At the same time, automatic signalling appeared on the local, or metropolitan type lines in the large European and American cities, because the capacity and rapidity at reaction of a human being did not allow of working such railways by mechanical type installations.

These first examples of remotely controlled and automatic equipment manifested the two fundamental tendencies seen in subsequent development, namely simplification of operations by greater concentration, leading to a saving in staff itself not well utilised, and the transfer of operations either not within the capacity of a man or such as could not reasonably be expected of him, to some apparatus. These two tendencies are seen in the latest installations in the form of partially or completely automatic operations.

What automation comprises.

In general the process of applying such automation may be divided into four elements :

1) transmission of information regarding the traffic situation obtaining;

2) use of such information to prepare the way for a single operation, or series of operations;

3) control of the particular items of apparatus involved in effecting such operation, or series;

4) proving that the operation, or series, has in fact been duly carried out by means of return indications detecting the altered conditions of the installation.

According to whether a man has or has not any operation to perform during the stages above given, such installations are said to be semi-automatic or purely automatic. In the case of the latter, it suffices to have certain supervisory staff capable of intervening at the appropriate moment should any failure of the equipment occur.

Nevertheless, in such cases, the human factor becomes of capital importance in the work of elaborating the general plan, in devising and designing the actual equipment required, and then caring for and maintaining it in good order. An automatic installation can only perform such operations and give such facilities as have been incorporated in the initial programme with the idea of meeting every possibility, and then only if it functions perfectly.

The equipment used.

The basic element in the Deutsche Bundesbahn's new signalling practice is the so-called geographical track diagram panel (Gleisbildstellwerk). Since it was first applied in 1950 to some large stations, it has given entirely satisfactory service under the most diverse operating conditions and in a great many different sizes, and has occasioned the introduction of other arrangements which, taken together, have effected a practical revolution in the control of the traffic.

Admittedly, certain elements found with the panel type of signalbox were known already and in use here and there, such as light signals and track circuits, in the locking arrangements found in mechanical type signalboxes, and the circuits met with in electrical ones using mechanical interlocking. These can be currently considered as forming part of the latest controlling and proving arrangements now seen in signal engineering, but only the resultant logical combination of all these items with the creation of the « all relay » method of working led to the geographical panel type of signalbox becoming the starting point of the process now in evidence.

As such the panel apparatus only effects a part of the programme given under (1) above; that included under (2) it does not itself perform at all; but the controlling (3) and proving functions (4) to a very great extent it does effect, although with a limit of from 1 to 1.5 km. It therefore needs to be supplemented by something else. One of its most important elements of proving and indicating of the condition of the lines by means of track circuits or axle counting apparatus, forms the connecting link between the vehicle on the track and the controlling and detecting part of the equipment and the basis of the information reflecting the operating conditions of an installation. On its correct functioning therefore depends the smooth and unhindered working of the traffic movements.

A completely automatic piece of equipment is seen in an automatic signal, an independent controlling device for a track on which no points exist. This uses also as its most important controlling element equipment (track circuits, etc.) reflecting the actual condition of the section of line ahead of it and, in contradistinction to the panel type signal box, involves no human intervention in its ordinary operation.

A supplement to the panel proper in the transmission of information, as referred to in (1) above, is seen in the train number describer. This enlarges the functions of the track circuiting — or equivalent apparatus — in that to the indication that a train is travelling in a given section it adds the information of what actual one it is; this apparatus itself is under the direct control of the track circuiting and therefore of the train movements.

To extend the range of the controlling (3) and proving (4) functions of the panel is the task of the remote control. By means of this, it is possible to bring under the control of a central point the intermediate normally unattended signal boxes of a section of route or the junctions of an interconnecting close network of routes.

Finally, the adjunct to the panel type of equipment the most difficult to realise, the making use of the information arriving at it, covered by (2) above, has lately been satisfactorily effected. With the aid of the train number describer, working in conjunction with the track circuiting, or its equivalent, a programmed form of control and hence automatic setting up of the routes for the trains, becomes possible, while in the work of sorting and marshalling trains the wiring up of the controls for the various operations, already often made use of, has been converted to fully automatic operation by means of automatic control of the rail brakes, or retarders, singly or in a series, on the system due to Grassmann.

Thus, the operations covered by modern signal engineering have been brought technically within the field of automation although the exact way in which that is effected in practice may change as development continues and experience is gained. This process and its bearing on the development of traffic operating methods is treated in this article within the limits of what is essential, items of equipment being only mentioned in so far as they have not been dealt with in earlier publications.

As a railway system consists firstly of the individual sections of route and then of the junctions and traffic centres where they come together, the following considerations deal first with the former, then with the junction stations, and finally with a complete but comparatively limited network embodying a combination of both.

Automation on plain open line.

Most lines of the Central European railway routes carry an irregular succession of trains varying in class, length and speed. This is the justification for the decentralised system of working, under which responsible staff — signalmen and station supervisors — deal with the situation as it obtains from time to time at the various intermediate stations on the lines, either as a result of the arrangements laid down in the timetable, or of any irregularities in the train running that may happen to occur. The attention they give to their work involves noting a number of indications of various kinds, observing, considering, and performing certain operations, under existing arrangements, for every train movement. This forms part of their duty, as it does that of the signalmen who are under their orders and of those in the adjacent block posts. In other respects, their field of action is limited as they have no general view of the operating conditions on the line concerned. This defect has been remedied to some extent on important sections by the institution of traffic regulating or controlling offices which, with the aid of information regularly transmitted to them, are able to form a general view of the situation and assist signalmen and station staffs by giving appropriate advice or instructions.

This decentralised form of traffic regulation and control is conditioned by the very form of the old mechanical and power signalling installations. While these, in conjunction with the care and attention given by the staff to their duties, provide for the safety of train movements, the various indications and messages and operations to be performed consume a great deal of time and demand numerous personnel and offer opportunities for misunderstanding and mistakes. As however, they continually recur in the same form and order, such a method of working itself leads naturally to the thought of making the entire process automatic.

The first step towards this is found in the adoption of the panel type apparatus. While retaining the decentralised form of control above mentioned, this enlarges the field of action of the station supervisor or person operating it, and relieves him of unnecessary work by eliminating the individual subordinate signalmen in the station area (fig. 1). The transmission of information and the decisions to be taken upon it remain indeed very much in the form hitherto known, but in the control and proving of the signals and points appreciable steps towards automation are realised. Instead of having to make some 30 movements — reading of indications and deciding what to do — and perform some 20 operations, involving walking about 80 m to deal with a through train movement, it is only necessary for the operator to make a single decision, press simultaneously two buttons and observe two indications on the panel, one before, the other after actuating the buttons, and this without moving a step. This partial step towards automatic operation is of decisive economic significance by reason of the saving in staff and reduction in work which come with it.

The second step is to render the control of following train movements entirely automatic. The replacement of the ordinary block posts by automatic signals and the application of automatic through working in the panel signal boxes at the wayside stations render any human intervention superfluous, as long as the trains continue to follow each other in the prescribed manner. In consequence, automatic signals are being increasingly applied on the heavily worked sections of line. As the signals take practically no time to operate and are independent of any human action, mental or otherwise, they not only allow of an increased train service being run but of the rapid disposal of any group of trains

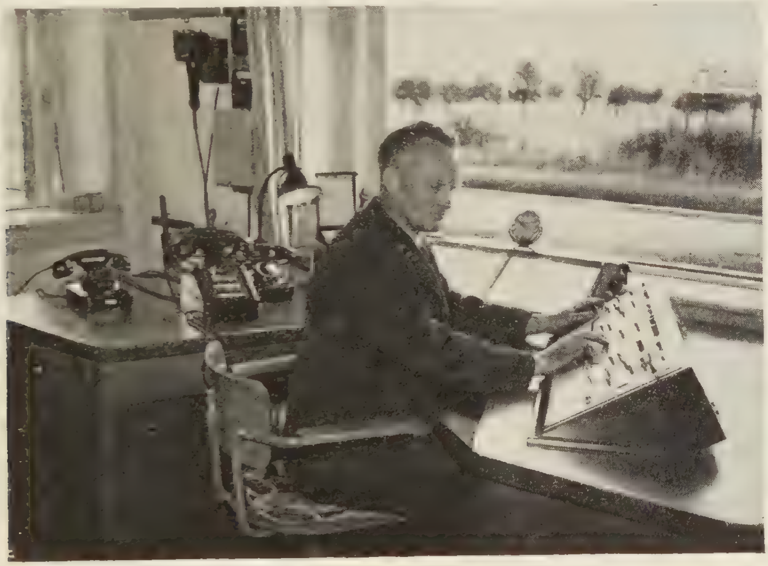

Fig. 1. — Panel type apparatus at an intermediate station.

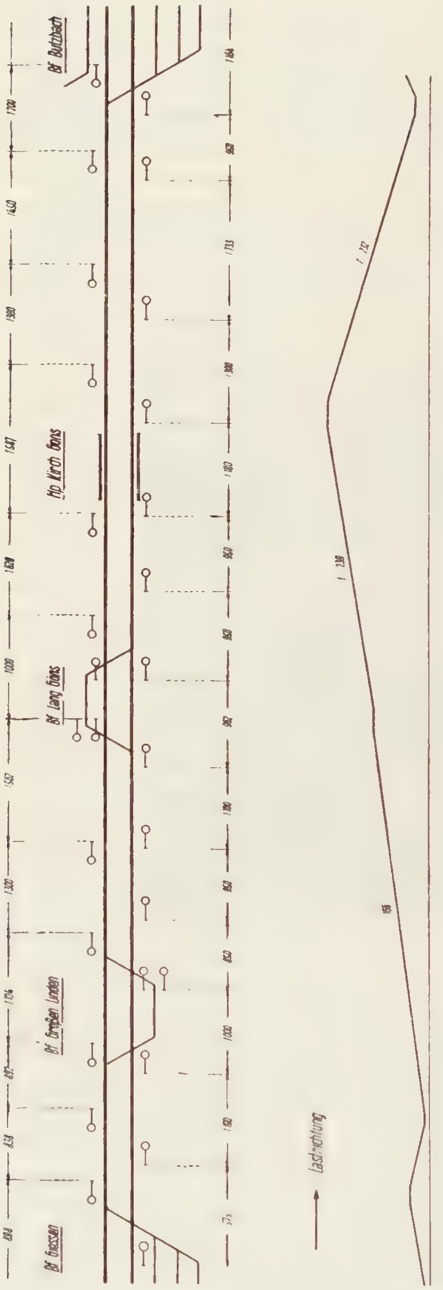

Fig. 2. — Arrangement of automatic signals on an upward gradient section carrying heavy traffic.

created by some irregularity in the working. As a rule, therefore, they are placed more closely together than were the old block posts (fig. 2).

The third stage in the process lies in the improved transmission of information to the person controlling the traffic by means of the train number describer. The train number — that is its number in the working timetable — is selected in the apparatus at the beginning of the section by the actuation of a transmitter, and appears on a track diagram at the controlling point (fig. 3). By means of the track circuits, the indication is caused to move forward with the train to which it refers, so giving the operator full and correct information respecting the entire traffic operating situation. The numerous telephone communications, both as far as he and the other local traffic controlling staff are concerned, are eliminated and he can give his whole attention to dealing with the clearing of any irregularities in the train working.

The fourth phase is seen in the elimination of the sending of instructions from the central controlling point to the outlying locations by applying direct operation through remote control. The earlier decentralised control of the traffic movements then disappears and the operator at the central point becomes the signalman for the entire section of line. There are no longer any local signalmen. Any deviation from fully automatic working is dealt with on the track diagram or panel covering the section, on which all stations concerned are shown (fig. 4). The results of actuating the push buttons on it are transmitted as « controls » to the individual stations over a pair of wires in a cable in the form of impulses, selected by relay combinations in the transmitter mechanism, and the information reflecting the conditions at the outlying location is sent back similarly in the form of « return indications ».

This then is the extent to which automation has been developed and applied to the control of traffic along a length of line, in its various stages. Every feature of it is there realised with the exception of the utilisation of information relating to any deviation from the normal through running. In this fourth stage therefore, human intervention still remains necessary; how far it may be possible to replace it by something else will be discussed later.

Experience with the installations so far constructed shows that a partial solution of the problem is able to bring savings and that it is not essential to aim at absolutely complete automatic remote control, although this remains indeed the ultimate objective. Partial automation is always to be recommended at those places where local staff must necessarily be employed for other purposes, such as working level crossing gates or barriers, dealing with special traffic matters or an increase in shunting movements, not dealt with in this article.

Automation at large traffic centres.

The most important task of the large traffic centres where several lines come together is to carry out the shunt movements required for handling, dividing and making up the trains, movements which as a rule call for a good deal of shunting motive power and numerous staff. They are not susceptible to being dealt with according to a fixed programme, except where they can be grouped into large sorting operations. In that case, the conditions for automatic splitting up of trains do obtain and can be met on the basis of the endeavours of many years past combined with the latest technical developments. The possibility of applying a high degree of automation already obtains therefore at such locations, side by side with a wide use of much individual action. This latter permits of being appreciably lessened by certain organisational measures, such as the return use of trains, labour saving train formation plans, careful timetable arrangements, combining of train forming operations, etc. There are, however, limits to such measures and if there is a small or moderate volume of traffic and the

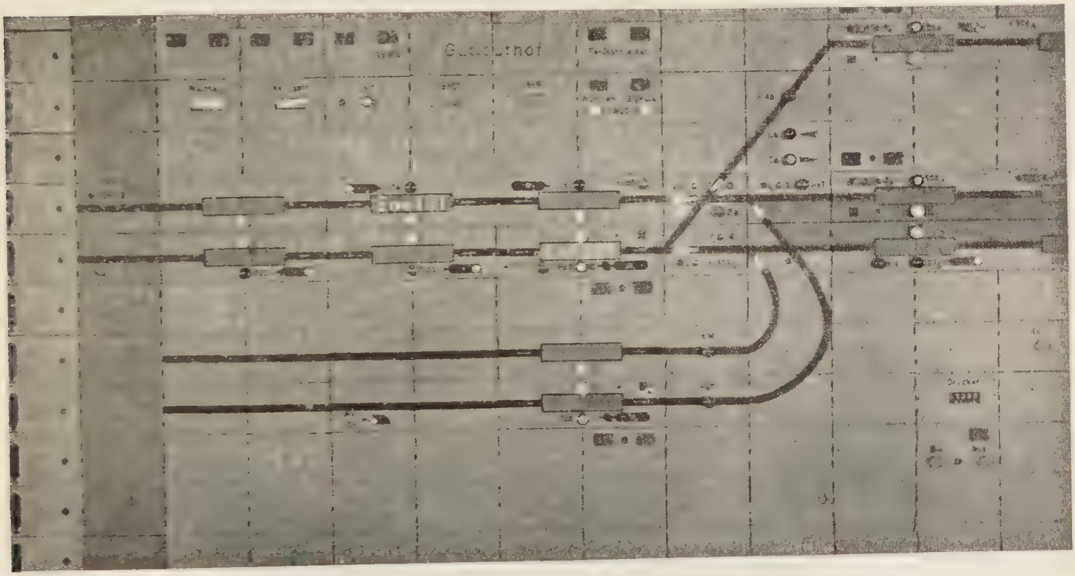

Fig. 3. — Train number indicating units on track diagram.

places (siding connections, etc.) where the operations have to be performed, are very scattered, then it becomes impossible to avoid the separate handling of vehicles or groups of them, and the moving to and fro of individual motive power units.

This method of procedure was until recently conditioned by the limit of range of a mechanical signalbox, the effort demanded of the signalman in dealing with the shunting operations and the insufficient communicating arrangements available. The larger junction stations therefore are equipped with a number of small signalboxes from which the shunting operations are handled individually and worked to and fro between them by the aid of messages in which there is always the possibility of a mistake occurring. Thus it comes about that, contrary to the practice on the West European and American Railways, shunting movements in Germany are protected only by the carefulness of the signalmen, shunters and engine drivers, and do not enjoy the same safeguards as the running movements.

As in such circumstances, complete automation is not feasible at present, the greatest degree of partially automatic working becomes the object to aim at. It is here that the panel type of apparatus in combination with modern methods of telecommunications, plays a decisive role. As far as the actual control and proving operations are concerned, the panel apparatus fulfils the programme completely. The signalman's work is reduced so that the range of action and hence the size of the signalbox can be appreciably extended; any other signalboxes become unnecessary and the involved exchange of messages between them is eliminated. Track circuiting,

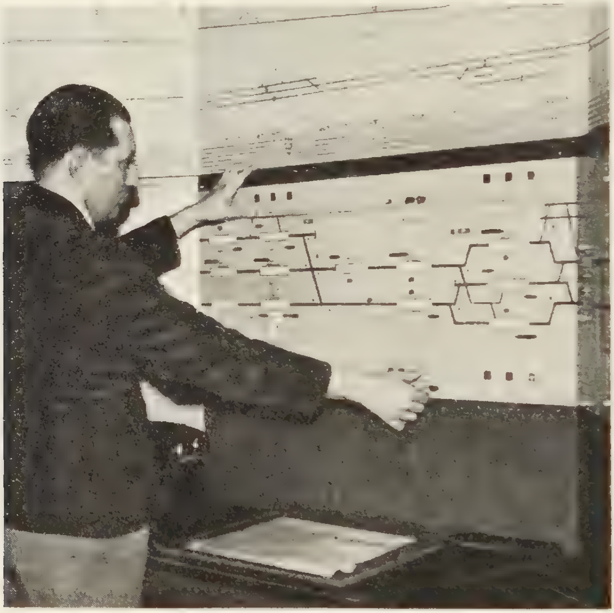

Fig. 1. - Centralised control panel for the line between Nüremberg and Ratisbon

or its equivalent, improves the view of the lines, the more so by increasing the height of the signalbox where possible, but above all, it is application of interlocked and signalled routes for shunt movements with fouling protection that gives the staff dealing with the shunting and the signalman the sense of working under a high degree of safety.

This strongly co-operative and co-ordinated method of effecting shunt movements and automatic form of control and proving operations are not attainable without improving the means of transmitting information. In this, wireless communication between the signalbox and shunting locomotive and the ground staff, equipped with portable apparatus, plays a decisive part. It is supplemented by loud-speakers in the yard by means of which the staff not reached by the wireless arrangements, such as for example the drivers of the actual trains, can be spoken to and further by the two-way speaker system between several fixed locations which require frequently to have an understanding with each other.

Automation does not come into this part of the working at all; here, as before, the man remains responsible but, being relieved of other activities, he can act over a wider field and with a greater degree of authority than formerly.

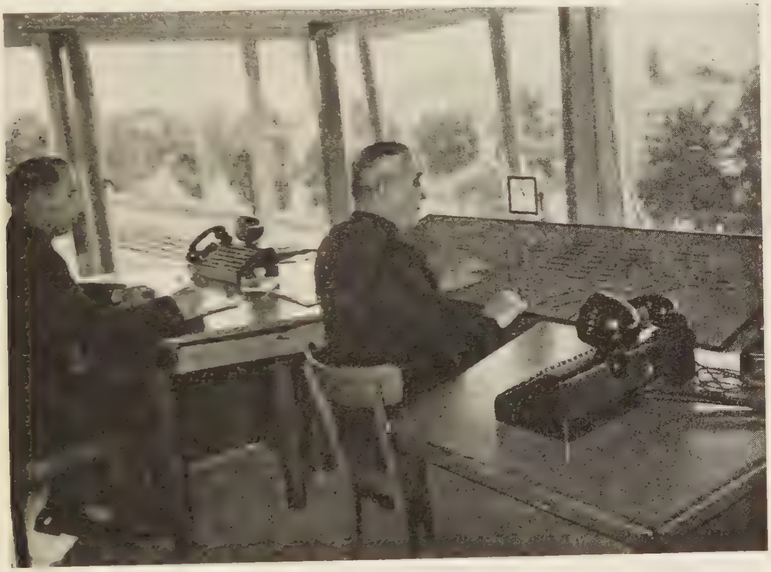

Fig. 5. — Panel apparatus at a medium sized junction station. (Bernsheim.)

This applies all the more when the signalman has not only to deal with shunt movements but, as is usually the case when his range of action becomes enlarged, with running movements also. As in the case of the panel installations at the wayside stations, it becomes possible to combine, as long as the amount of work does not exceed a certain limit, the duties of a signalman with those of a traffic supervisor. Signal boxes of this kind are already to be found at a number of medium sized junction stations (fig. 5); by their aid the best possible handling of the entire traffic, both running and shunt movements, is ensured. Should the work involved at times become greater than normal, the supervisor can be helped by assistants, as for example by a train registering and describing assistant, should the train number describer equipment fail or not be provided, or by an assistant signalman, seated at a shunting desk panel, which can be switched out normally, or at a section of the train panel, when there is an extra amount of shunting to be handled. Only in the case of really extensive installations with a large number of train movements and frequent irregularities in the running does it prove impossible to do without a special official whose duty it is to regulate the traffic as a whole. Whether such a supervisor shall be provided with his own panel from which to transmit his orders (fig. 6) or, as is now being sought to do, shall be placed in authority as directing official over one or more supervisory signalmen at the ordinary panel to give orders directly to them is a question to be decided by those in charge of the traffic working which is itself, as has been shown above, considerably influenced by a partial application of automation to the various operations.

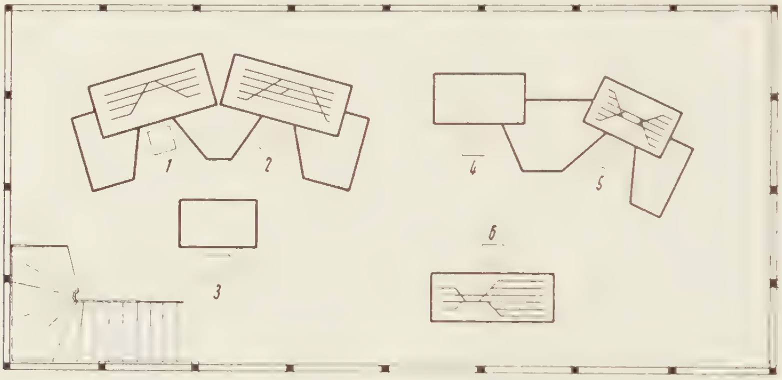

Fig. 6. — Diagram of arrangement of panels in a central signalbox at a marshalling yard (Mainz-Bischofsheim station).

1 : West side supervisor. — 2 : East side supervisor. — 3 : Train information inspector. — 4 : Shunting supervisor. — 5 : Hump and retarder operator. — 6 : Signalman for the locomotive yard shunting area (Floor 15 m above rail level).

How far the information transmitted from point to point can be brought effectively within the scope of this possible use of automation will be dealt with in the next section of this article. It does indeed allow of being applied to what has already been mentioned, the work of sorting trains in marshalling yards, and to such an extent as to serve as an example pointing the way to a possible completely automatic control of the traffic.

As it is at present the marshalling or train cut sheet forms a programme of the operations required to sort a particular train, but the practice obtaining hitherto of drawing this up from details recorded on the ground and duplicated by hand, using wireless or telephone messages, offers scope for improvement or even elimination by teleprinting the information concerned from the departure station. While the train cut list is being received on the teleprinter at the marshalling yard signalbox or control room, a punched record card can be simultaneously prepared, to replace the operation of storing the re-

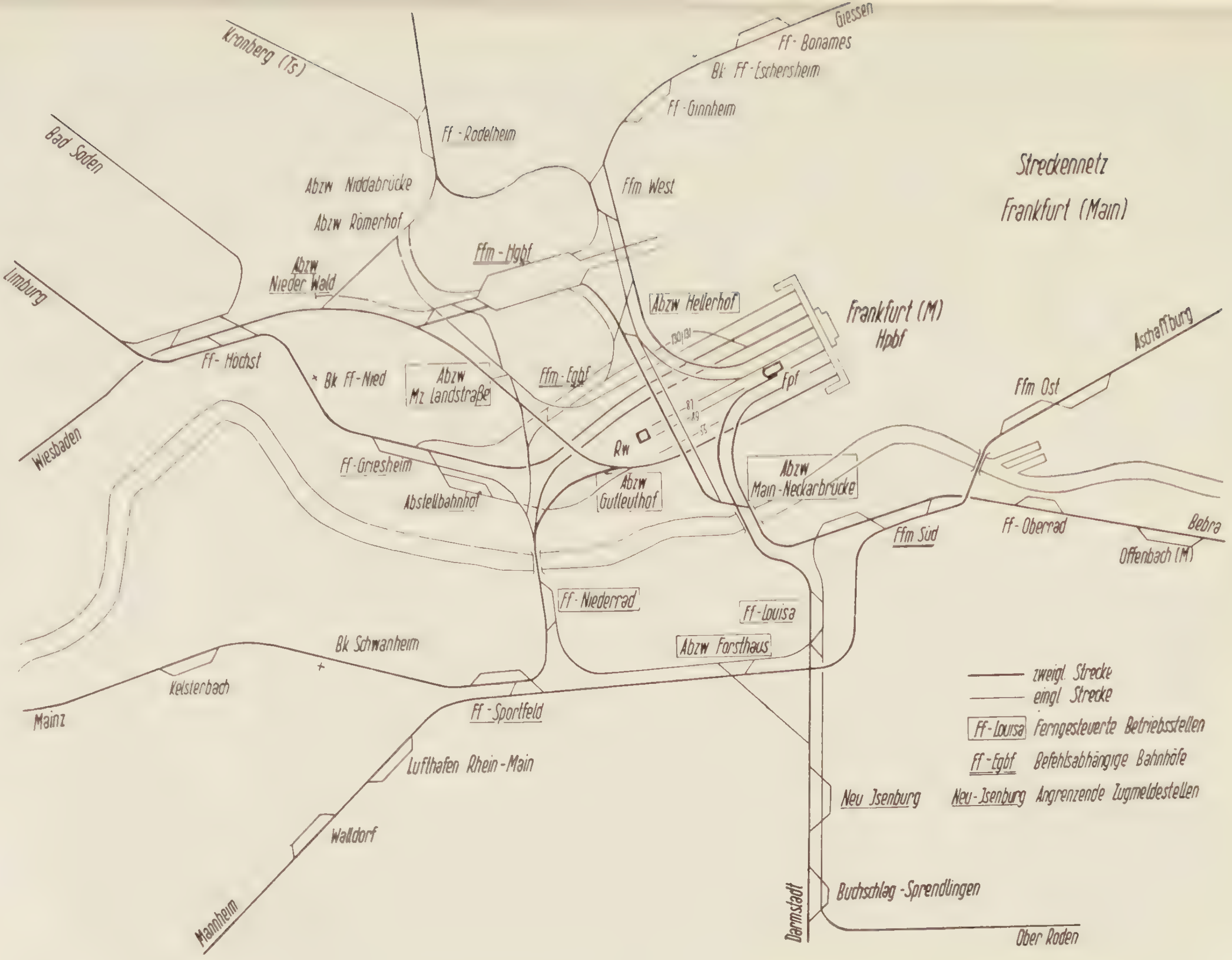

Fig. 7. — Panel controlling working of outer area at Frankfurt (Main).

N.B. — Streckennetz = network. — Zweigl. Strecke = double track line. — Eingl. Strecke = single track line. — Ferngesteuerte Betriebsstellen = remotely controlled stations or junctions. — Befehlsabhängige Bahnhöfe = stations with signals slotted from the central signal box. — Den ferngesteuerten... = train describing points nearest to the remotely controlled stations or junctions.

quired point controls in the apparatus, hitherto performed by the signalman or operator. Storing of automatic point controls for sorting movements in hump yards has been known for thirty years and well proved itself; it has been applied for the first time since the war in more up-to-date and extended form in combination with panel apparatus at Gremberg yard. This has to be supplemented, however, by automatic control of the retarders in order to allow the wagons to run into the sorting sidings without collision. This problem is still being investigated and trials of equipment are being made; the elements of a solution are already to hand in the automatic transmission of information concerning the weight, speed, running resistance and running distance of each wagon. With these go automatic combination of these factors in a calculating apparatus, automatic control of the retarders through radar effected speed measurement, and also automatic proving of the operations. After leaving the first, or hump, retarder the wagon reaches the series of retarders arranged on the Grassmann system (¹) with the correct stipulated speed, and these, also functioning automatically, give it the final permissible one of 1 m per sec.

Such a far reaching degree of automation applied to sorting operations and partial use of it to deal with other shunting processes offer a means of altering the whole organisation of the working in the marshalling yards. The high degree of concentration of the various operations and easing of the work of the staff by eliminating certain tasks, offers the possibility of housing the reduced number of directing and supervising persons required in the main hump signal box or control room, so enabling them to work in close co-operation with the signalmen themselves (fig. 6) (²). In this case, the shunting or marshalling supervisor has similar functions to those exercised by the principal supervisor, or traffic controller, in large passenger stations.

Automation applied to a complete network.

Sections of route with the junction stations form together a more or less self-contained network of lines within a given traffic area. The various elements forming a partial or complete means of controlling the train movements will in future regulate the working within such a network. Functioning in a co-ordinated manner they point the way to the adoption of a fully automatic programme control over the entire train working.

A picture of such a network is to be found where numerous routes approach and join each other in the vicinity of large centres. These form a small scale layout in which, owing to the close train headway, density of the track arrangements, short distances between signalboxes, block posts, etc., and the numerous passenger and goods stations, the working of the traffic becomes often much more difficult than in a system of lines spread over a considerable area. Here, above all, the need becomes felt, with the adoption of the latest signalling equipment on the various lines and at the junction stations, to try and render such complicated working independent of human action.

An example of this is seen in the lines around the great traffic centre of Frankfurt (Main) (fig. 7), where, for the first time, an automatic train routing installa-

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(¹) GRASSMANN : « Die Automation und ihre Anwendung im Ablaufbetrieb der Rangierbahnhöfe ». (Automation and its application to hump marshalling yards). « Die Bundesbahn », 1956, p. 595.

(²) KÜMMEL/BERTRAND : « Die betriebliche Organisation der Rangierbahnhöfe und ihre Weiterentwicklung durch die neue Signal-, Fernmelde- und Ablauftechnik ». (Organisation of marshalling yards from the operating point of view and their further development by the latest signalling, telecommunication and hump yard engineering). « E. T. R. », Special number No. 6; « Rangiertechnik » (Marshalling yard technique). No. 15, page 27.

tion is in service. There are here some 1 700 trains every 24 hours, on 11 converging and often heavily loaded approach lines, requiring to negotiate several bottlenecks as they are routed into and out of the stations. An especial difficulty is created by the dense passenger train movements at the business peak period and the large number of heavy freight trains which have to be dealt with in the marshalling yard in the city area. The essential problem lies in bringing under a central control the numerous junctions and small stations hitherto working in a completely de-centralised manner and unable to have their working co-ordinated for want of suitable equipment, and at the same time relieving such central control of the task of performing directly the operations necessitated by the complicated traffic conditions by applying fully automatic controls. Individual bottlenecks, such as the Francfurt-Niederrad station (3) where 400 trains from seven routes have daily to be passed over two tracks on the river bridge, or the Hellerhof junction with nine converging lines are amongst the most difficult layouts to work, so that bringing them under the control of a central supervising point makes considerable demands on the latter. On the other hand, the difficulties met with at these locations themselves arise from the fact that their own range of action is limited and a general view of the position throughout the whole area is lacking.

The foundation for a solution of the problem is found in equipping the junctions with panel apparatus, in the extensive use of automatic signals on the lines between, in applying train number describers the information in which is fed into them from outlying points, and which cover the whole area and parts of the lines leading to it, and in adopting remote control by which the panel installation can be worked from the central point.

This example goes to show the applicability of complete automation within a given network of lines.

Summary.

The transition to automatic working is thus developing with the aid of the most varied applications of signalling equipment, both in form and in adaptation to the operating methods employed. To begin with there will be a partial automation, using human intervention as a controlling and checking factor, in some cases as a final stage, in others as a preliminary one leading more and more to full automation. On the open line various stages are seen leading to remote control; at the junction stations, there are the centralised signal boxes, effecting an improvement on the situation previously obtaining, both from the technical and economic standpoint. In addition, however, automatic train routing in a given area, automatic hump yard working and the increasing use of automatic signals on ordinary sections all combine to show that full automation of railway operation is close at hand, and where it is feasible to apply it, will not fail to bring a great reduction in the work of the traffic staff, an increase in operating capacity, and efficiency, and excellent economic results.

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(3) Kockelkorn/Kümmell : « Der Umbau des Bahnhofs Frankfurt-Niederrad als Anfang der Erneuerung der Signalanlagen im Frankfurter Raum ». (The rebuilding of the Frankfurt-Niederrad Station, as first stage in the modernisation of the signalling in that area). « E.T.R. », 1955, No. 7, page 295.

[656 .257 (43)]

The new central signalbox at Frankfort (Main) Station, controlling the operation of the traffic in the surrounding area,[1]

by Dipl.-Ing. Karl Friedrich KÜMMELL.

(*Die Bundesbahn*, No. 17, September 1957.)

In July and August 1957 in accordance with carefully arranged plans, the new control signalbox at Frankfort (Main) was successfully brought into service in several stages. Since August 11th, 1957, the day on which the two remaining principal signalboxes of the old installation were put out of use, the largest signalbox on the German Federal Railways has been operating with a full staff. On september, 20th, its opening was formally commemorated by an appropriate ceremony.

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[1] A description of the latest development in signal engineering, as seen in this Frankfort central signalbox, was given by the present author in No. 16 of « Die Bundesbahn », in an article on the application of automation to railway working with the aid of such developments, to which therefore reference may be made. (« Die Automation des Eisenbahnbetriebes mit Hilfe der Signaltechnik »).

Two and a half years spent on construction and installation were thus brought to an end, a short interval for such a many sided and extensive piece of work. Only by intensive efforts was it possible to keep to the close limit of time allowed, prescribed four years before, in the face of difficulties with the delivery of materials and want of trained installing and supervisory staff.

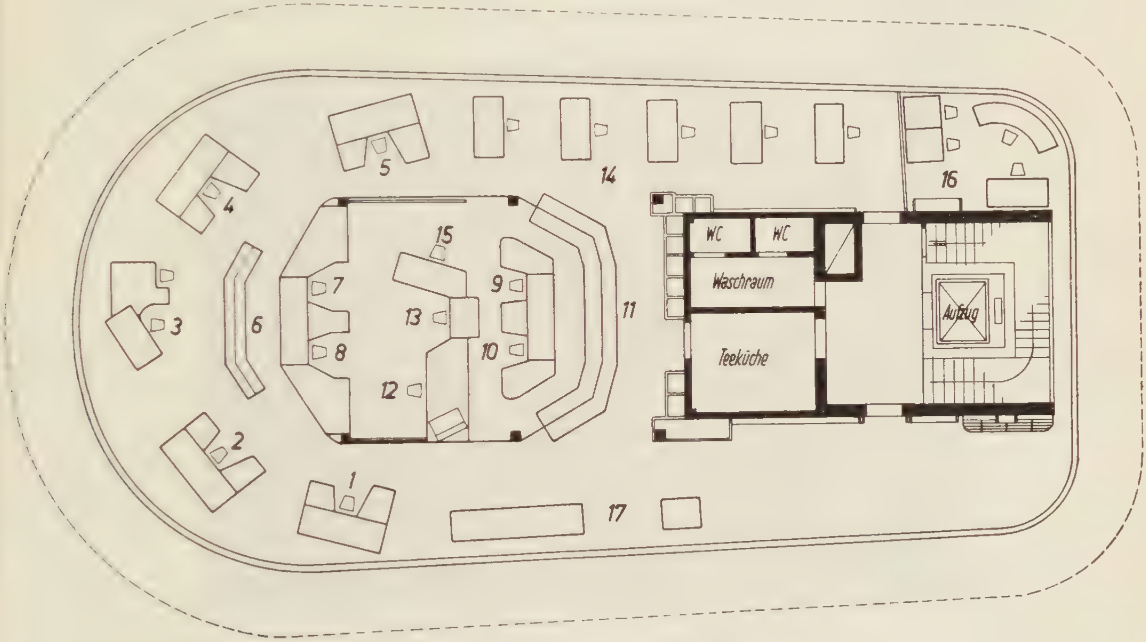

Fig. 1. — Plan of the control room.

1-5. Control desks.
6. Station describer panel.
7 & 8. Station regulators (supervisors).
9 & 10. Line regulators (signalmen).
11. Centralized control panel.
12. Telephonist (Train announcer).
13. Station supervising.
14. Station control.
15. Chief of staff.
16. Telegraph.
17. Panels for the switching of the contact line and the lighting of the tracks.

N. B. — Waschraum = bathroom. — Teeküche = kitchen. — Aufzug = lift.

This new signalbox is the outcome of many years experience in designing and constructing equipment of this class, combined with the latest and most progressive ideas on traffic operation and the adaptation in a rational manner of the most recent developments in signal engineering. The signalbox is not merely noteworthy by reason of its size; it is especially remarkable for the degree of concentration of control over the traffic which it affords. Admittedly, the local conditions were favourable to this, with the dense layout of tracks and points and the close network of approach and connecting lines in the immediate area. This facilitated bringing together the operating and supervisory functions. In planning the work, however, many unknown factors were involved, which had of course to be estimated and later confirmed by practical experience. It can already be said however that the results of this new form of controlling the traffic are beginning to show themselves, and with this central control office — for in fact this signalbox can be described as nothing less — an important step forward has been taken towards an altered form of conducting the operation of a railway, the full significance and possibilities of which cannot yet be realised.

Technically what is fundamentally new in this lies not in the mere combining of equipment already known, such as the DrS type panels, automatic signalling, train number describers and remote control, although here combined on a scale hitherto unknown and improved in certain details for this particular installation; it is to be found in the application for the first time of the automatic setting up of routes, yet to be brought into operation as the concluding stage of the work. It is true that in America the automatic setting of junction facing points on city rapid transit lines has been seen for some little time now, but this solves only a simple element in the problem. In the complicated layout of lines in the Frankfort area, however, automatic train routing involves problems so difficult and varied that their solution results in every individual point of this complex network being brought under effective control, thus pointing the way to full automation in railway working.

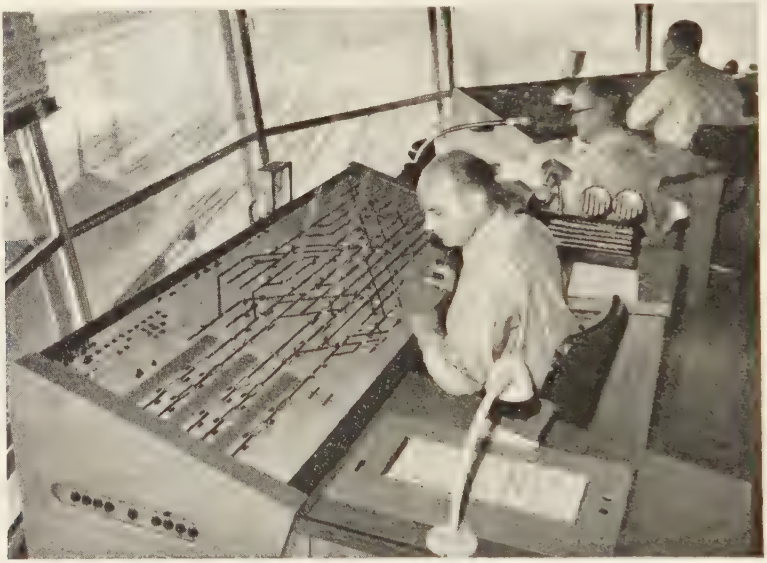

Fig. 2. — Control desks 1 and 2.

The reasons for rebuilding the signalling installations in this area were the worn condition of the heavily worked electric power signal boxes erected in 1912, the continually increasing frequency of the trains and large number of shunting movements, for the handling of which the speed of operation of the nine signal boxes no longer sufficed; also the lack of adequate safeguards for the shunting movements and a centralised supervision and direction of the traffic operations in the area as a whole.

The discussions on how best to meet these difficulties when planning a new installation tended more and more to the idea of using the advantages offered by the latest signal engineering practice to effect the maximum concentration of supervision over the traffic flow. Thus not only are the signalmen and those directly supervising them located in the one room but also the officials directing the station working itself and supervising the traffic as a whole, in this way bringing under the one group of staff the outlying stations and junctions in the area around the main station.

The whole of the operating equipment and apparatus working therewith are assembled in a towershaped building located centrally among the lines near the ends of the platforms, replacing nine signal boxes, two intermediate block posts and a traffic control office. The operating room (fig. 1) is on the completely glazed fifth floor, affording an all round view over the whole of the station track layout. In the projecting front semi-circular space there are five desk type panels from which the points and signals of the station are controlled. Their size is such that the signalmen can operate them confortably when seated and reach the telephone and self moving time table located on side tables (fig. 2). Each panel bears a representation of a length of track extending from the platform buffers to the farthest train stabling lines and the home signals on the routes approaching the station area. The amount of the layout so covered includes a certain area in which up to three shunting movements can be in progress, and the limits between it and neighbouring similar divisions are so arranged that very few shunting or train movements require to pass between them while, at the same time, all five signalmen have about the same amount of work to do. The determination of these divisions was the result of a long investigation into the traffic requirements, forming the initial stage in the autumn of 1952 of the planning of the work (fig. 3).

On the basis of previous experience, the duty of handling between 800 to 1 000 shunting movements in 24 h was allocated to the staff at each individual desk, to which of course ordinary train movements had to be added. It was not possible, however, to divide the shunting area equally, so that, for example, panel 5 is more heavily worked than the others in these respects. The man doing duty at this panel, including a diagram of tracks on a small area with 135 points and stops as well as 104 stopping light signals, will probably be aided permanently by a train message assistant, while at the other panels it will be possible to dispense with this help after the signalmen have become sufficiently accustomed to their work.

These signalmen direct the shunting movements from the panels on their own responsibility, the shunters' requirements being communicated to them by wireless. Four wireless frequencies are in use for communicating with the seven shunting locomotives in service simultaneously, and are so allocated that the signalmen at panels 1, 2, 4 and 5 can each, without disturbing the others, keep in touch with the shunt movements he is dealing with, while panel 3 shares the frequencies allocated to the remaining panels.

The signalman at panel 3 has a special duty to perform. He controls a very small area in the centre of the station layout and has little to do with running movements. On the other hand, the shunting movements are very numerous and form a compensation for areas 2 and 4; they include the locomotive movements between the Rw (panel) type signalbox in the adjoining depot and the platform lines, amounting to some 600 daily. This signalman is assisted by a locomotive describer, which announces to him by numeral indicators, the numbers of the trains to which particular locomotives have been or are to be attached. The locomotives are offered and accepted, sent to and fro over the three connecting lines and signalled to

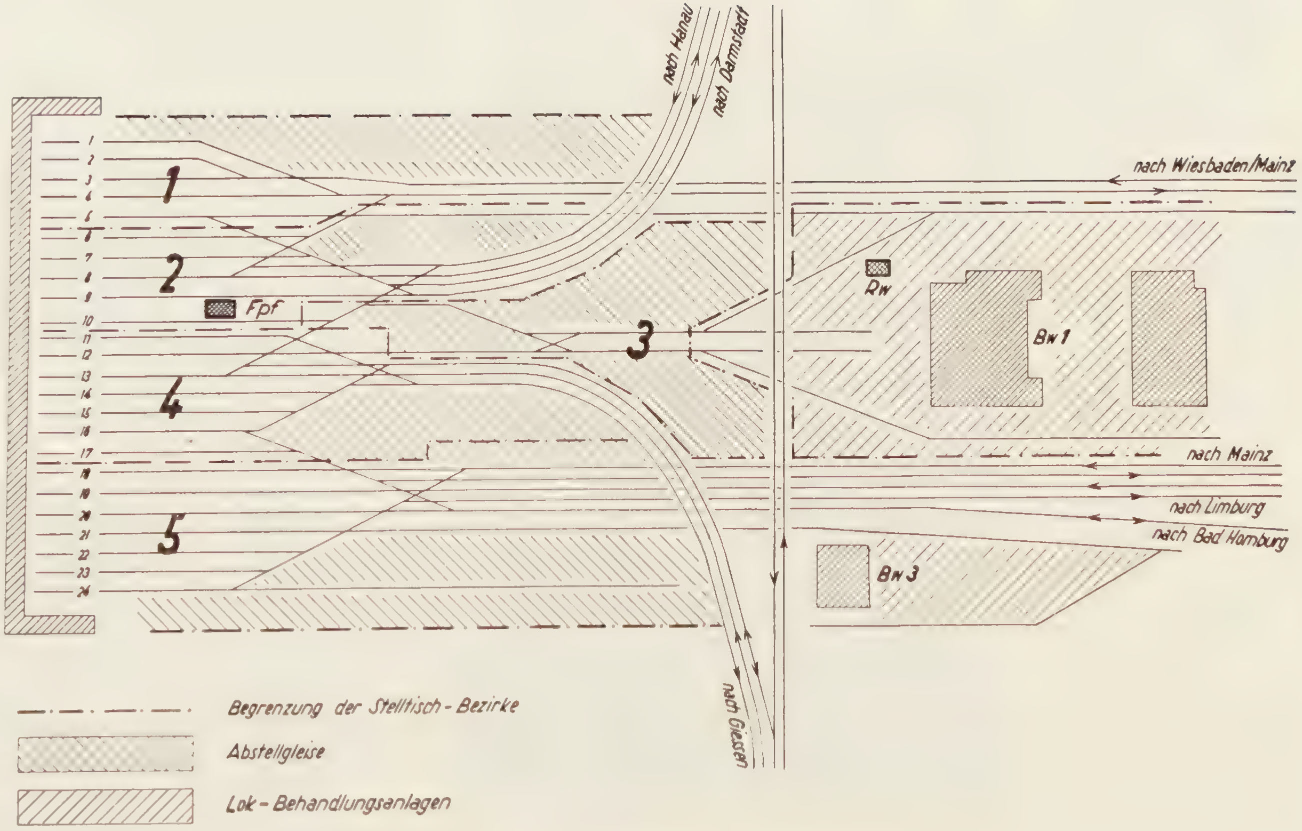

Fig. 3. — Section delimitation of the control desks.

N. B. — Begrenzung der Stelltisch - Bezirke = section limits. — Abstellgleise = depot sidings. — Lok - Behandlungsanlagen = locomotive maintenance installations.

the neighbouring areas without a single word requiring to be spoken.

This installation effects an appreciable reduction in the work, compared with what was required previously. This is the case also at the Rw signalbox which, as part of the complete scheme, was provided to replace four previously in service; with 2 400 shunting movements daily its panel is probably the most heavily worked of all. Its first year of operation has proved that the exclusive use of fully signalled routes for shunt movements in the confined and heavily worked track layout of a locomotive depot speeds up the working and increases the level of safety. (For details of the planning of this signalbox see the article in *Die Bundesbahn,* No. 7, 1954, entitled : « Wechselbeziehungen zwischen Personaleinsatz und technischer Plannung bei Errichtung neuer Stellewerksanlagen », by **Happel** [The relation between staff requirements and engineering design in the construction of new signalling installations].)

The two supervisors, or leading signalmen, who control the main station area, are seated together in the centre of the semi-circle above mentioned where the other panels are located. Their own practically vertical panel is so arranged as not to prevent them from seeing the lines outside and to give them a full view not only of the ordinary signalmen's panels but of the working of the traffic itself in the station. A modified form of the indicating type of panel introduced with the Dr (push button) system for the use of supervisors was therefore provided. This long and narrow panel on which the lines are represented vertically on account of the breadth of the station, is carried on a special low framework in front of the slightly raised desk at which the supervisors sit (fig. 4), and by means of the train number describers, indicates approaching trains up to a distance of about 3 km. The push buttons are not, as is usually the case, arranged geographically but in rows on broad faces on the surface of the desk. They

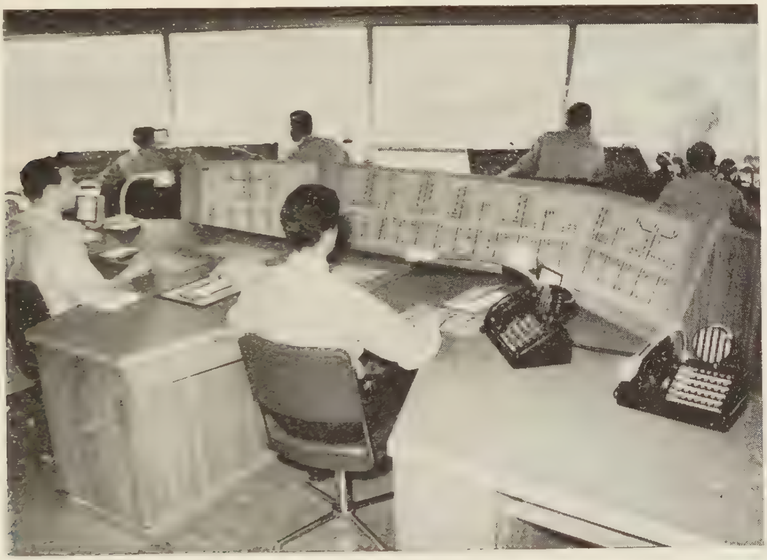

Fig. 4. — Station describer panel.

are divided into track and signal buttons and placed conveniently to the right and left respectively of the supervisor (fig. 5). The telephone and self-moving graphical station timetable and train time recorder complete the equipment. Room has been left for a train recording and reporting assistant, to meet the case when for any reason it should become necessary to replace or supplement the train number describer by telephone messages.

In the rear part of the operating room is located the outer area supervisor's panel which, divided into north and south sections, presents a diagrammatic view of the approach and connecting lines in the whole area (fig. 6) (2). With their aid, the two central principal supervisors direct the working over the entire group of lines with the aid of an extensive system of train number describer indications and thus are in a position by reason of the complete information provided regarding the traffic situation, to intervene when required and fulfil the duties of traffic controllers. Their principal work lies in dealing with the traffic to and from the principal goods station, express parcels depot and the Frankfort South goods station, all of which has to pass over lines heavily loaded with passenger traffic, and is liable to interfere with it. For the first time it becomes possible, with the view of the whole situation given by the panel, to decide the correct starting times for the departing goods trains, which frequently are heavy and are only able to move away slowly on the sharply curved rising gradients. It is for this reason that the clearing of the starting signals is made dependent upon the consent of the central supervisor.

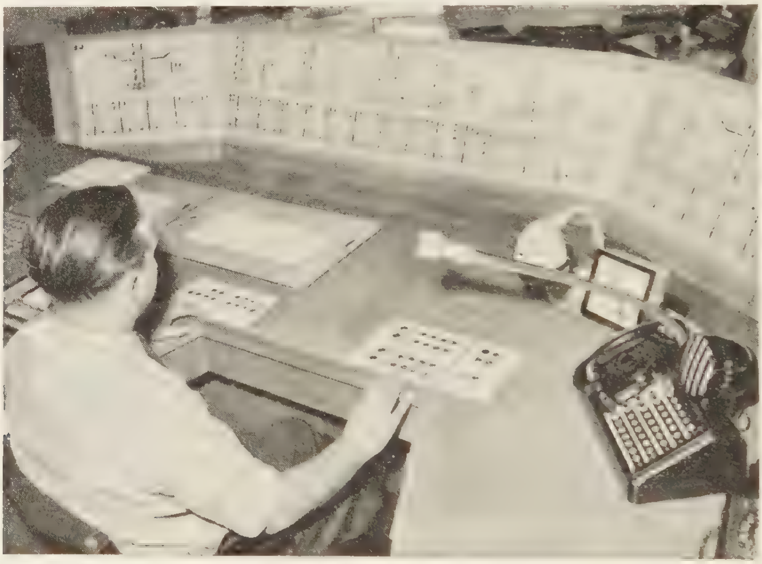

Fig. 5. — Control desk of the station regulators.

An essential element in any control of this kind is the train number describer apparatus. This has proved itself already in a number of stations, but hitherto has not been provided in such a developed and closely interworking form as here. The working is concentrated in the central signal box where the train numbers appear as illuminated numerals on rectangular frosted glass plates in the relevant places on the outer area track diagram of the approach and station lines. On this, there are 230 such describer indicators with in addition on the signalmen's and station supervisor's and train announcer's panels another 256, to repeat the information for the benefit of the other persons concerned. The numbers of the trains approaching Frankfort are described by the supervisors at the next station, on each line, where staff are on duty, as soon as the information is received by telephone from the station in rear. The number so transmitted then appears on the outer area panel on the track concerned and moves onwards past the remotely controlled stations with the train as it proceeds to the main station. Here for departing trains the numbers are selected and transmitted by the signalmen at their own panels and again move forward with the trains to the outer stations. At each of these, there is a small panel on which the number lights up on a diagram of the final block sections and becomes extinguished when the train concerned arrives. This eliminates all telephonic train describing throughout the area.

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(2) A diagram of the lines in the area was given in No. 16 of « Die Bundesbahn », fig. 8, p. 1170.

In order to give the central supervisors direct control over the train movements through the most heavily loaded junctions in the area, the panel installations at seven stations and junctions have been brought under their remote control. These seven locations are shown on their own panel (fig. 7), which provides the same indications and is fitted with the same push buttons as the local panels, which are switched out of operation when the remote control is in service.

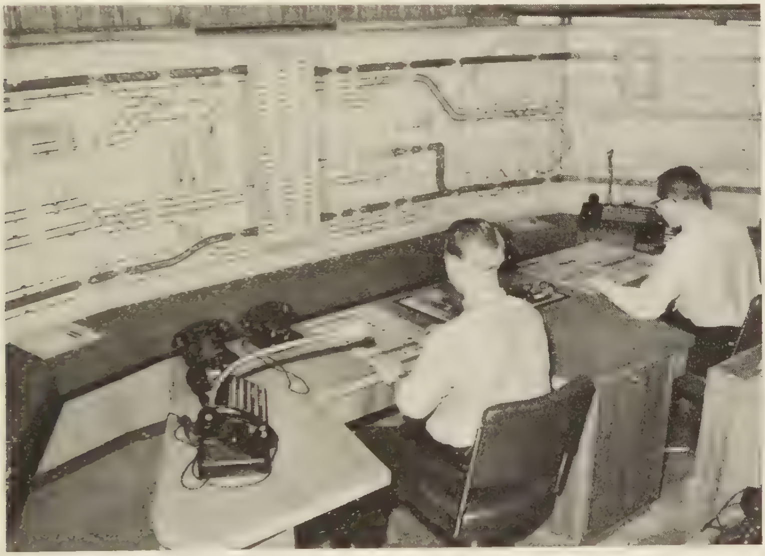


Fig. 6. — Centralized control panel.

As part of the complete work, therefore, five outlying junctions and a station were equipped with panel installations, to enable them to be remotely controlled. In addition, the one put into service in 1953 at the Niederrad station, with reversible working facilities, also was brought under remote control. The planning and installing of these new signal boxes which at first had to be operated locally, required the solving of a number of operating and engineering problems, as at most of them the track layout is very complicated with several lines coming together. Some idea of this may be gained from the fact that at the Hollerhof junction nine lines are involved, giving 96 routes for running movements, with 22 others to provide for certain emergencies and to afford alternative paths. On the lines between these new signalboxes and the central station itself, a large use is made of automatic signals so as to divide the previously unequally lengthed block sections and enable the trains to follow each other more closely, thus clearing the points of congestion more rapidly.

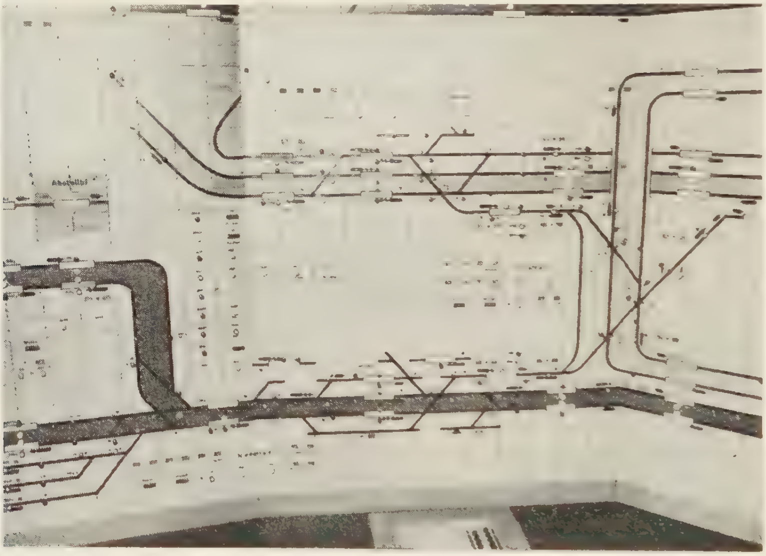


Fig. 7. — Track diagram of the telecontrolled points on the centralized control panel.

To lighten the work of the central supervisors the push buttons are duplicated on his desk in front of the panel, being let into the surface, as in the case of the desks used by the station supervisors (fig. 8). These officials therefore, as all others in the signal box, are able to carry out their duties seated and need only go to the panel itself if something unusual occurs.

The necessity of being constantly on the alert and ready to act, in consequence of the great frequency of train movements within their area, would nevertheless prove excessively burdensome, and therefore, a system of route setting by the trains themselves was developed. The originality of this consists in making use of the train number describers for this purpose. The ordinary five unit numbers are prefixed by a route or direction sign which is automatically taken into account by the apparatus, while each train selects the route for itself in accordance therewith, all control impulses not immediately able to be used being stored and such routes as are free to be used becoming selected by the magazine mechanism. Such working presupposes that there is no fixed order for the trains; nevertheless the central supervisor is at all times in position to give precedence to a particular train or hold one back without disturbing the automatic working in any way.

This equipment will give the central supervisors the relief and time they need to make the necessary arrangements for the control of the train movements and to take decisions quickly, frequently necessary. One of their functions is to direct the movements within their own area in such a way as to harmonise with the capacity of the central station and the conditions obtaining there. They have therefore to work in close co-operation with the station supervisors and it is for this reason that they have been located in the same part of the signal box.

Both central and station supervisors are assisted in their work by the general traffic controller who links together the knowledge of the train movements in the immediate Frankfort area with the information coming from much further out concerning any late running on the part of approaching trains. His desk is placed also in front of the outer area panel, a little higher than those of the supervisors seated at it, and he notes in his register the various train movements and makes the necessary arrangements inside the station itself should any irregularity or late running occur. Beside him is the woman train announcer for the platform loudspeakers who herself has a special indicating board on which the trains about to arrive or depart are shown. The locomotive supervisor also is associated with the general traffic controller and with the shunting inspector. Both are located near the principal controller in the northern corridor of the operating room. The station master or his representative has a special desk close to the outer area panel.

The bringing together in one space of all the officials concerned in directing the traffic results in a great concentration of functions hitherto not seen in a station of this kind. The main centre of work and responsibility is represented by the signalmen at the five panels covering the station itself and the central or outer area supervisors. On the skill with which these men carry out their duties depends the unhindered movement of the succession of trains running on the approach lines and arriving at or leaving the station at intervals of frequently only a few minutes. Their task consists, more than ever before, in arranging, considering and deciding upon the traffic possibilities from one minute to another. A mistaken estimate of a particular situation can have far reaching consequences. In this respect, the station supervisor and general traffic controller have not so much to deal with as formerly, for although they possess a comprehensive view of things, they are some-

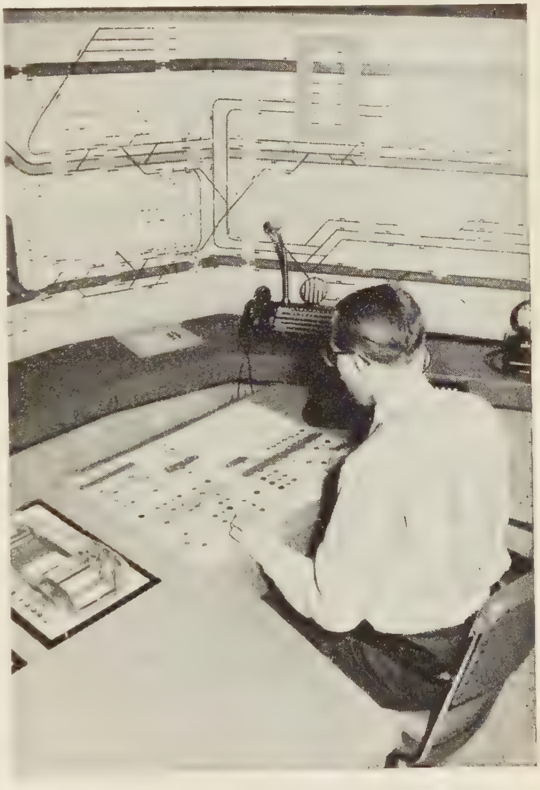


Fig. 8. — Control desk of the line regulators.

what removed from the responsibility of dealing with the immediate operating position.

This new method of working results in the various officials having to accustom themselves to changed conditions and to make appreciable efforts to do so. Experience with it gives rise to the question whether the various supervisory functions, separated in accordance with earlier practice in dividing up such things, cannot be to some extent combined. Such considerations will lead to the development of a new way of conducting traffic, at first within a limited network of lines, for which this new central signalbox offers an excellent testing ground.

Of considerable importance is the accompanying reduction in the number of staff required. The more complete the equipment and the more organised the working, the fewer the men needed to deal with the traffic, and hence the less also the number of instructions, messages, and co-operative movements. To avoid, however, overburdening the remaining staff their duties require to be intelligently and equally divided, but it must be remembered that in the initial stages some assistance to help them in their task and enable them to adapt themselves to it, is required. It proved possible to reduce the signal box staff for the central station itself from 105 to 43 or 59 %, and that required in the remotely controlled area from 42 to 8, or 81 %, in addition to which savings in supervisory staff may be anticipated, so that finally about 100 men will be released for important work elsewhere. This represents an appreciable saving in staff costs.

The most important supplement to any such concentration of signalling equipment lies in the realm of communications. The traffic could not be handled without wireless communication with shunting movements, two-way loudspeaker communication between the various panels and desks where much telephoning requires to be carried out, and loudspeakers alongside the tracks. A so-called « Basa » 300 line exchange with motor driven selector switches, has therefore been erected to serve the central station and junctions and stations in the area, with the 85 signal post telephone locations provided therein. Four frequencies are used for the wireless shunting communication and three for operating to the signal and overhead catenary maintenance staffs. The point cleaning staff, also shunters and maintenance men, are to have portable wireless sets. The telephone equipment at each signalman's panel (fig. 9) is of either the 40 or 80 way general speech type, in some cases with similar apparatus connected in parallel for the use of an assistant. In addition to the normal microphone-loudspeaker, in this case connected as loudspeaker only, each speaking point has an interference free microphone, proof against external noise, mounted on a swan neck bracket, with special loudspeaker for the communication with the shunters. The signalbox is also connected to the teleprinter network — using both the so-called spring and Hell types of machine — and to the pneumatic tube message carrier system of the divisional management.

The damping of the noise in the operating room in which at times 18 people are working and speaking and are being communicated with over loudspeakers, offered a serious problem. These sources of noise are augmented by the sound of trains and locomotives, and by the conversation of visitors and maintenance staff who may come to the signalbox. It became necessary therefore to seek various ways of diminishing the noise to prevent it from becoming too great and interfering with the work to be done. The most important thing to do was to keep the activity of each individual within his own proper field of work, so avoiding conversation with others. Such communication between persons as is unavoidable is mostly effected by visual indications (train and locomotive number describers, transmission of orders, etc.). Sufficient space is allowed between each person to keep annoyance caused by overhearing loudspeaker messages to a minimum. The loudspeakers themselves are so adjusted as to be damped down to the level just required for satisfactory hearing; for this, for the first time, two stage amplifiers were used, with separate adjustment for incoming and outgoing messages. The microphones are of such a degree of sensitivity that the noise must be kept subdued when using them, which in turn keeps down the general level of noise. Outside noise and vibration is excluded by means of double windows and an insulating floor. Finally ceiling and walls, supports, and certain desks, etc., have heavy coverings of sound absorbing material, the effect of which is increased by carpets on the floors. Echo effects have been largely eliminated by avoiding parallel surfaces on the walls. The results are satisfactory; as a rule only a low general sound prevails in which nothing particular can be distinguished and which in general does not interfere with anyone's work or power of concentration. With a greater degree of carefulness when speaking, still to be attained, especially in the use of the shunting wireless communication, these conditions will in due course become still further improved.

General working conditions are made still more comfortable by the use of air conditioning, which feeds cooled or warmed air to the operating room, by the provision of a kitchen alongside it, adequate accommodation for clothes, bathroom with shower, and a passenger lift.

The windows in the operating room measure 2 m from floor level and are sloped outwards to eliminate the effects of reflection. They form a polygon towards the front, with faces 2 m long. Sloping the windows in this way of course results in the ceiling being reflected in them, and this has therefore been coloured a flat blue. Lighting the individual desks sufficiently therefore became a difficult problem, since no source of light or illuminated object can be permitted to be seen reflected in the windows. Hooded lamp units have therefore been let into the ceiling immediately over each desk which through a suitable cover glass throw a soft light directly on it. For reading and writing purposes, the new table type lamps, designed in the Central Engineering Office of the Bundesbahn at Munich have been provided for the first time. The outer area panel, standing at the back of the room cannot be seen reflected in the windows and is therefore lit by a neon tube.

On the three floors below the operating room are the apparatus rooms. Without windows and rendered proof against dust, these contain the relays referring to the points and signals, train number describers and the remote control. A few figures will give an idea of the size of this installation. With the six new signalboxes at the outlying junctions and the one con-

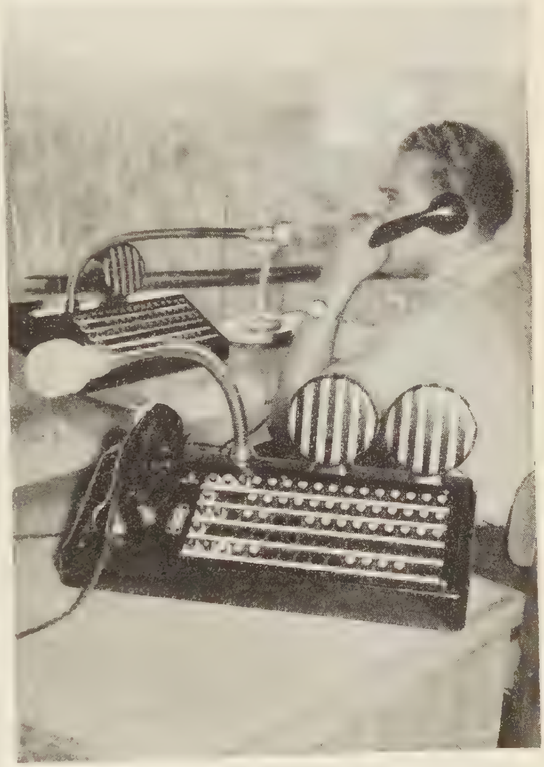


Fig. 9. — 80-way speech type general exchange with microphone mounted on swan neck bracket and special loudspeaker for radio-communication with the shunters.

trollling the shunting in the locomotive depot, known as Rw, there are 546 sets of points and derailers, 120 home or starting signals (including 35 automatic signals) 121 distant signals and 470 position light ground signals and signals for dividing the station platform lines. In the central station itself there are 421 routes, regular and auxiliary, for running movements, and 1 463 shunting routes; the outlying locations involve 264 routes for running movements. There are about 20 000 relays controlling the signalling itself, another 20 000 for the train number describers, and 40 000 for the remote control. About 250 km (155 miles) of cabling in and outside the signalbox were required and 8 000 km (5 000 miles) of ordinary wiring. Some 2.4 million soldered connections had to be made, either in the factory or on site.

The central signalbox at Frankfort is as yet the largest complete and self-contained signalling installation on the German Railways and was constructed by Siemens and Halske A. G. Wernerwerk für Telegraphen- und Signaltechnik, Braunschweig, in admirable co-operation with the responsible German Federal Railway authorities of the Frankfort Division Management, exactly to the prescribed programme. A special construction staff was established for the work, attached to the operating superintendent's office at Frankfort.

It is intended, within the next few years, to extend the area controlled from this signalbox. The train number describer working is to be extended, as existing signalboxes become converted to panel installations and additional automatic signalling is brought into service, so as to permit train movements being followed up to a distance of 15 km (9.3 miles). In this way, remote control and automatic operation will become continually enlarged to cover more outlying junctions and stations, so that eventually a comprehensive network of lines, equipped with automatic apparatus, will surround the signalbox at the central station. This will thus partake more and more of the character of a central traffic control point, arranged to supervise and direct the working on a closely knit and complicated network of routes, with the lines leading thereto, in conjunction with its principal centrally located station, and manned by a relatively small staff, themselves aided to the fullest extent by automatic devices.

[621 .438 (73)]

UP 8 500-HP turbines ready to roll.

Locomotives can haul 5 000-ton train 1 811 miles from Los Angeles to Omaha with only two intermediate stops for fuel.

(*Railway Locomotives and Cars*, January, 1958.)

Mastiff and chihuahua. — The engineman looks down from the cab of the 8 500-HP gas-turbine-electric locomotive.

The first of fifteen 8 500-HP gas turbine-electric locomotives for the Union Pacific is now practically completed. The locomotives were ordered from the General Electric Company late in 1955. The original design was described in the January 1956 issue of *Railway Locomotives and Cars* and component parts were described in the July 1957 issue. Information on the completed design has been made available in a paper by F. D. Gowans, General Electric Company, presented before the December 1-6, 1957, annual meeting of the American Society of Mechanical Engineers.

The 8 500-HP gas turbine locomotives were designed and built on the basis of experience gained from the operation of 25, 4 500-HP units, the first 10 of which went into service in 1952. The Union Pacific still has a large number of steam locomotives operating between Ogden, Utah, and Cheyenne, Wyo., which it wishes to retire. For this purpose they have wanted a locomotive with more weight on drivers and a higher horse-power-per-ton ratio for the purpose of handling high speed, long distance freight.

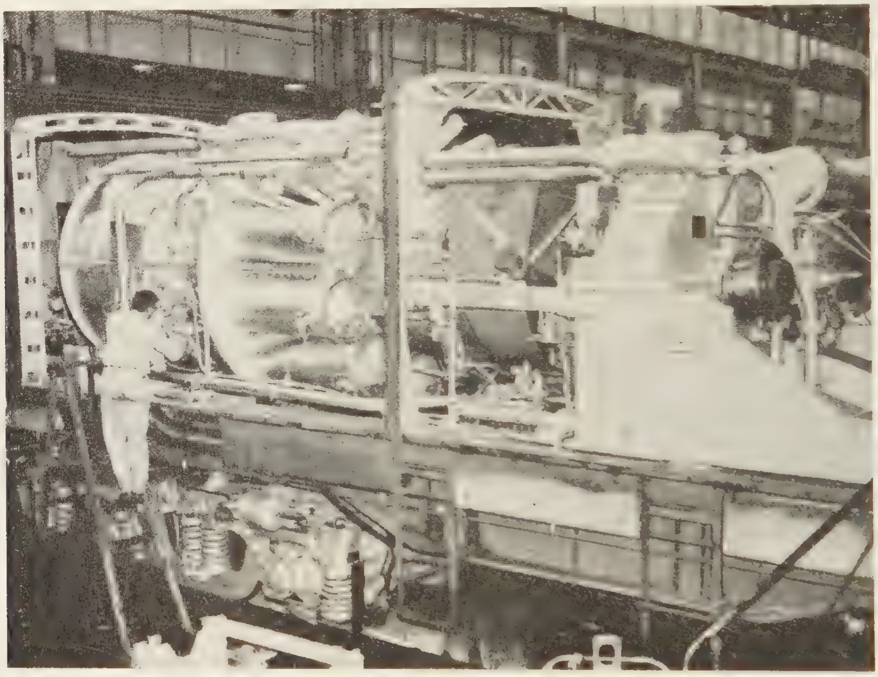
All these factors are embodied in the new locomotive. It consists of two units and a fuel tender. It is 175 ft. long overall. It has 828 000 lb on drivers, and will handle a 5 000-t train at 17 m.p.h., on a 76-mile, 1.14 % grade. Geared for 66 m.p.h., it has 20 HP per ton of weight on drivers as compared with 16 on the 4 500-HP locomotive. Speed at continuous rating is 18 m.p.h.

The A unit is essentially an auxiliary. It carries an auxiliary diesel engine, a cooling system for the engine and the gas turbine lube oil, two air compressors, air brake reservoirs, control, a 2 500-gal fuel tank which supplies the diesel engine at all times and the turbine during starting, and other auxiliary components. The only main power components in the A unit are the six traction motors, control for these motors and braking resistors for eight traction motors.

Other main power components: the gas turbine generator set, six traction motors, control for these motors and braking resistors for four motors, are arranged in the B unit. Each unit is carried on two three-axle trucks with all axles motored.

Heavy fuel for the gas turbine is carried in the tender coupled to the rear of the B unit.

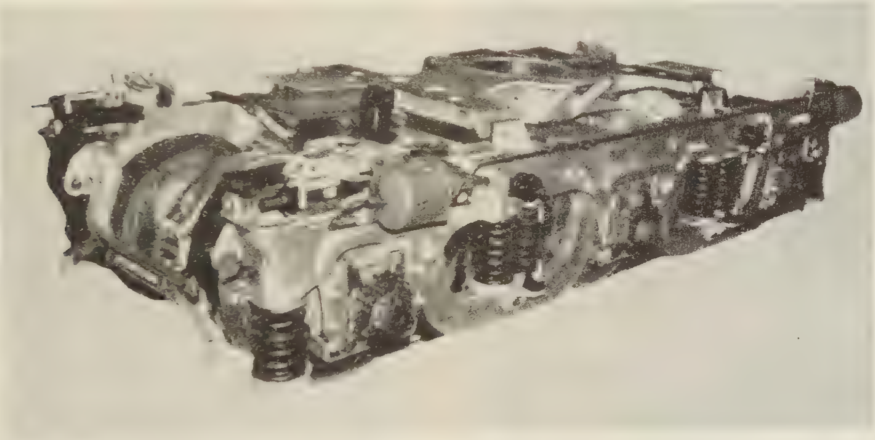
With the main power source, gas turbine, and generators located in the B unit, it is necessary to connect power circuits between units in order to supply the traction motors and dynamic braking grids in the A unit. These connections are arranged in panels on each side of the end doors with quick disconnects so they can be uncoupled easily. Electrical control, a diesel fuel line, two water lines and the usual air brake lines also connect between these two units. The fuel line supplies diesel fuel to the gas turbine during the starting cycle, and the water lines connect the turbine lube oil



No aisles or runways are possible in the B unit since the diameter of the turbine is 10 ft.

cooler on the B unit to the radiator system on the A unit to consolidate the cooling system. These $2^{1}/_{2}$-in. lines are located at the roof section. The flexible hose connections are supported in horizontal loops to give the flexibility and radii necessary for this size hose.

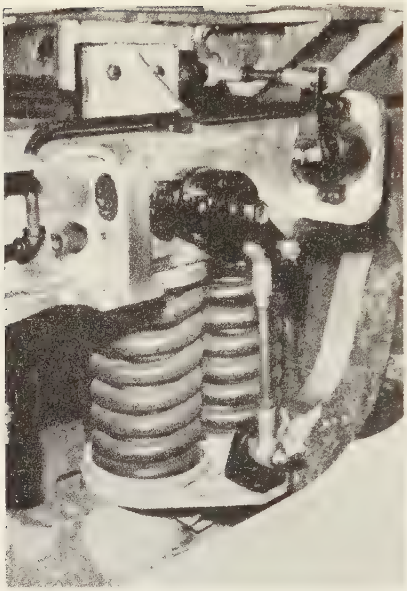
Connections between the B unit and the tender consist of the heavy fuel oil supply and return line, electrical connections for heating and lighting the tender and a tracer line for keeping this fuel line warm.



The truck bolster is supported on four rubber pads. Stability of the truck is maintained by shock absorbers between bolster and side frames. Tractive and buffing forces are carried from the bolster to the truck frame by lugs on the bottom of the bolster.

The diameter over the turbine casing in the B unit is 10 ft., requiring the full width of the cab to accommodate it. The four main generators are supported on a platform integral with the turbine gear case in order to simplify the alignment problem and to allow a completely integral power plant design. The overall length of the power plant, from generator to turbine exhaust tail cone, is 41 ft. Because of the unusual length of the unit, and the deflection and twisting normally encountered in a locomotive platform, the method of support is of considerable interest. The generator gear unit and the turbine are inter-connected and mounted on the platform by means of a flexible shaft coupling and a dual three-point casing support arrangement. This connection permits twisting of the turbine with respect to the generator gear unit while maintaining alignment. Two flexible legs support the generator gear unit on the platform, and a centering pin in the plane of these legs engages a recess in the platform to take the buffing and coupling shocks. Two flexible legs and a key support the turbine unit to the platform. The legs are welded to the platform and support the generator gear and turbine units by means of trunnion bearings attached to the lower casings. The legs are flexible only in the longitudinal direction; laterally they are quite stiff. The purpose of the flexible legs and the key is to permit freedom of longitudinal movement of the entire unit around the buff pin to care for expansion and contraction with temperature changes.

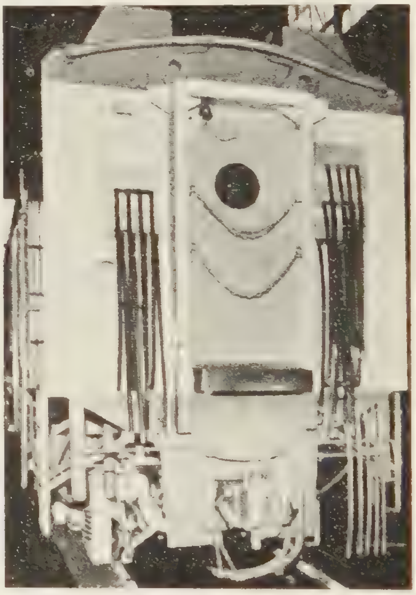
The angle of the exhaust gas tail cone, 30 deg. upward from the horizontal, adds to the overall length of the turbine, but is a means of improving the locomotive



Detail of one of the trucks showing the hydraulic shock absorber.

Flexible leg and trunnion for supporting the turbine from the platform.

performance. In addition, difficulties encountered from exhaust gas recirculation in tunnel entrances will be largely overcome. The 4 500-HP locomotive must travel 2.3 m.p.h. faster than the air in a tunnel of 410 sq. ft. cross section, in order to avoid any recirculation of exhaust gas. The 8 500-HP locomotive needs to run only 1.4 m.p.h. faster than the 4 500-HP locomotive to achieve the same performance at the tunnel entrance. The higher horsepower capabilities of the new locomotive enable it to run 25 % faster with its rated tonnage than the 4 500-HP locomotive.



Rear end of the A unit showing connections between cabs.

Platform and cabs.

Removing heavy fuel from the locomotive to the tender and designing for a nominal 68 000 lb. per axle, required that considerable weight be built into the A unit structure, since this unit, which would normally carry the fuel, now carries auxiliary equipment only. Structure numbers and sheets are heavier than would ordinarily be required and the top and bottom plates of the platform are 1 $^{1}/_{2}$ in thick. Based on usual design practice, there is 80 000 lb. built into the unit for ballast alone.

In contrast to the A unit, the B unit structure, with its 150 000 lb. of power plant, has been designed very carefully to meet the specified axle weight. High tensile steel is used in the sills, deck plate and draft gear housings. The sills have been reinforced by means of a fish belly 12-ft. long at the center of the span to maintain normal platform deflection and to accommodate the turbine lube oil sump and traction motor air duct to the rear trucks.

On the A unit, all the cabs are welded and become an integral part of the platform. However, the two end cabs are not fastened to the center cab. These joints are left free so that the loading and buffing stresses will be confined to the platform and not transferred into an integral cab structure.

On the B unit, only the front and rear cabs are welded integrally with the platform. The center cab, housing the power plant, is made up of a top and two side pieces. These are bolted to each other and to the platform. Any part can be removed independently of the others for work on the power plant. If desired, all the three pieces can be removed as a unit from the platform for removal of the complete power plant.

It was considered essential in a high-speed freight locomotive of this type, geared for 66 m.p.h., to have a swing bolster truck. The bolster is supported on four rubber pads. These pads are built up of alternate layers of rubber and steel bonded together. Flexibility of the rubber in shear permits lateral motion of the bolster within design limits. The resisting force built up in the rubber as it moves sideways tends to restore or center the bolster when the lateral force is removed.

Tractive force and buffing force are transmitted from the bolster to the truck frame by means of lugs on the bottom of the bolster which engage the cross ties between the truck side frames upon which the bolster is supported.

Stability of the truck is maintained by means of hydraulic shock absorbers between the bolster and side frame and the equalizer and side frame.

All controls for starting and stopping the diesel engine and the gas turbine are located in the A unit. An engine panel with the necessary controls and indicators is mounted near the diesel engine, as is customary on diesel-electric locomotives. Controls for the gas turbine are located at the engineman's position. After starting the engine, these controls permit the engineman to hostle the locomotive using the diesel engine-generator connected to two traction motors. Speeds up to 20 m.p.h. can be obtained with the locomotive and loaded tender on level track. This feature provides for minimum operation of the turbine at idling and light-load conditions. Considerable saving in fuel is thereby realized at yards and terminals.

The turbine is started on diesel fuel because it is easy to ignite and is more fluid than the heavy oil at low temperature. The engineman simply pushes the starting switch. A pneumatic, cam-operated controller automatically controls the starting cycle, brings the turbine to idle speed and then switches from diesel to heavy fuel. It likewise controls the stopping cycle. Switching back from heavy to diesel fuel, it flushes the heavy fuel from the lines and stops the turbine.

[625 .172 (73)]

How the M & StL got a tighter grip on M/W inventory,

by B. T. Rodgers,

Vice President & Comptroller, Minneapolis & St. Louis — Minneapolis, Minn.

(*Railway Track and Structures*, June 1958.)

The need for keeping close control over maintenance-of-way materials has attained a new importance. This has resulted in the need for improved methods of accounting. On the M & StL this problem has been met by the introduction of a simplified and mechanized accounting system. The plan not only pinpoints shortages and excesses of items on a month-to-month basis, but has also enabled the road to cut its M/W inventory in half.

Our inventory investment in maintenance-of-way materials at the end of 1957 was $ 1 600 000. Four years before it was $ 3 300 000. Cutting this investment in half was made possible by simplifying and mechanizing our accounting procedure. This permitted our road to control the buying, transferring and allocation of our materials on an efficient basis. The new accounting system also has resulted in very substantial reductions in clerical work.

The new system was proposed and installed in 1954. It was the result of a comprehensive survey made in the summer of that year by the public accounting firm of Arthur Andersen & Co. The objective of this review was to make an appraisal of the railroad's present system and to make specific recommendations for the modernization of all accounting policies and procedures.

The former accounting system was inadequate for present-day operations. Common deficiencies were : Excessive clerical costs in handling inventory paperwork; lack of monthly reports on the status of the inventory; the physical inventories and material usage were priced at the latest prices, which resulted in substantial overstatements or understatements of the inventory; and the location of important material could not be readily determined, resulting in a larger investment in inventory.

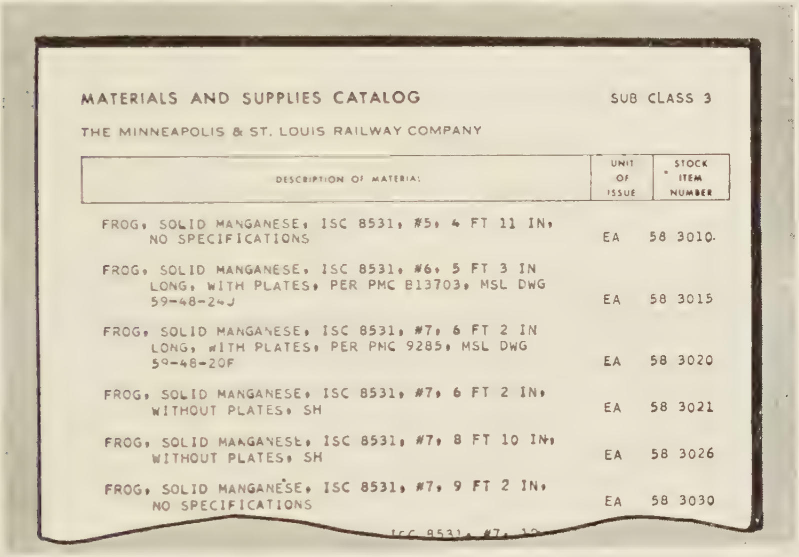
Installing the system.

The first step was to prepare a comprehensive detailed catalog of all materials and supplies used in the day-to-day operation of the railroad. In developing the catalog, inventory classes were established based on our own requirements rather than AAR classes. An M & StL stock number, containing six digits, was assigned to each item. The first two digits designate the class, the third the subclass, and the last three the part number (fig. 1).

Specific forms were developed for inserting the description and price of each item. These forms were then keypunched and the catalog was prepared mechanically on continuous form multilith mats processed through an IBM 407 accounting machine. The catalog contains approximately 25 000 separate items and consists of approximately 1 000 pages.

On November 1, 1955, a physical inventory was taken of all materials and supplies. M & StL stock and location numbers were assigned each item. Next, the location number, stock number and quantity of each item were keypunched and priced mechanically and the beginning inventory for mechanized procedures was completed.

plus freight. At the end of the month, if materials are received but not vouchered, unvouchered receipts are handled on the same basis using system average prices.



MATERIALS AND SUPPLIES CATALOG SUB CLASS 3

THE MINNEAPOLIS & ST. LOUIS RAILWAY COMPANY

DESCRIPTION OF MATERIAL	UNIT OF ISSUE	STOCK ITEM NUMBER
FROG, SOLID MANGANESE, ISC 8531, #5, 4 FT 11 IN, NO SPECIFICATIONS	EA	58 3010
FROG, SOLID MANGANESE, ISC 8531, #6, 5 FT 3 IN LONG, WITH PLATES, PER PMC B13703, MSL DWG 59-48-24J	EA	58 3015
FROG, SOLID MANGANESE, ISC 8531, #7, 6 FT 2 IN LONG, WITH PLATES, PER PMC 9285, MSL DWG 59-48-20F	EA	58 3020
FROG, SOLID MANGANESE, ISC 8531, #7, 6 FT 2 IN, WITHOUT PLATES, SH	EA	58 3021
FROG, SOLID MANGANESE, ISC 8531, #7, 8 FT 10 IN, WITHOUT PLATES, SH	EA	58 3026
FROG, SOLID MANGANESE, ISC 8531, #7, 9 FT 2 IN, NO SPECIFICATIONS	EA	58 3030

Fig. 1. — First step in setting up the new inventory accounting system was the preparation of a detailed catalog of materials and supplies. This is a typical page from the 1 000-page catalog.

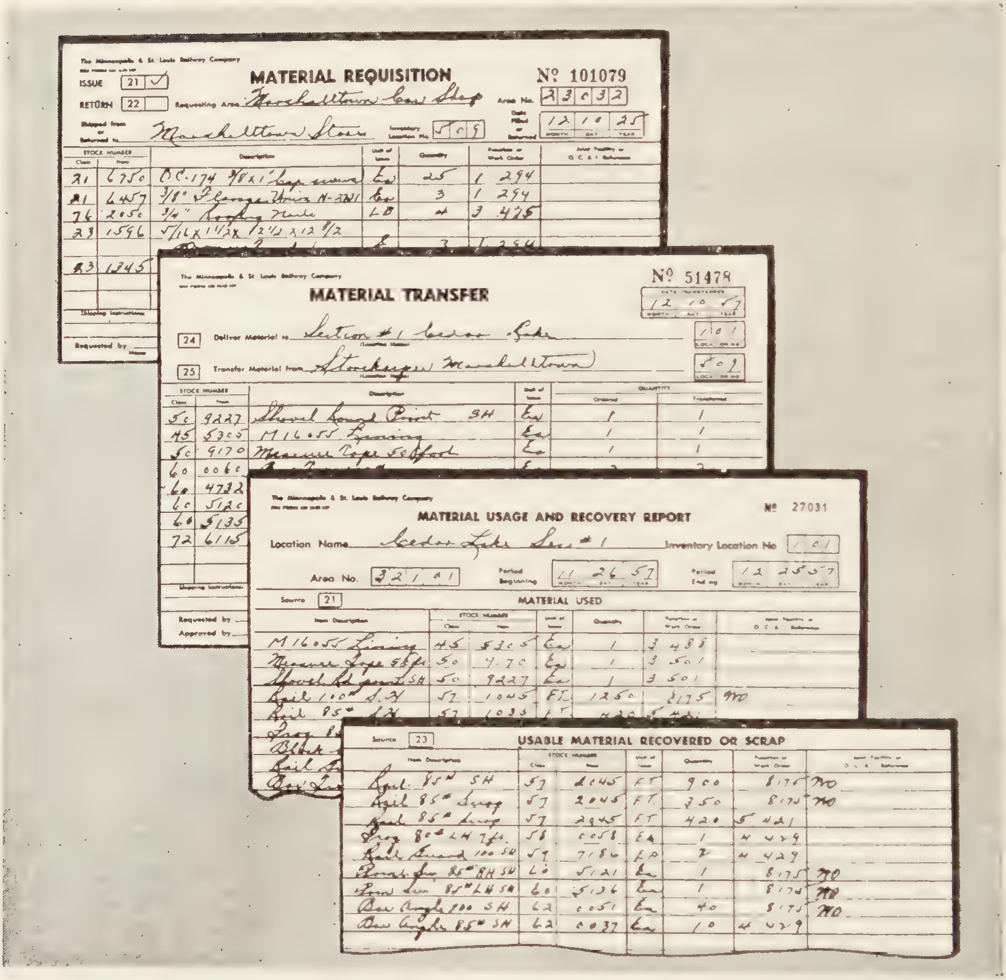
Month-to-month procedures.

Each month the section foreman responsible for a particular inventory location prepares the necessary reports to reflect the particular month's usage or activity. Forms have been developed for material usage reports, material returns to stock, salvage, transfers and adjustments (fig. 2).

Material receipts at a particular location are handled in two ways. One would be a transfer from another location or storeroom, in which case the transferring location makes out a transfer ticket. The second method would be by direct purchase. When the vendor's invoices are processed, the inventory purchased is charged to a specific location at actual cost. The price used for each inventory item is the cost

Each month the material transaction reports are keypunched, verified, mechanically priced at the system average price, and extended by an IBM 604 calculator. The distribution to a particular operating account on substantially all of the inventory is predetermined. In other words, the particular ICC account that a particular inventory item is normally charged is predetermined. The only changes required are those for differentiating between charges to yard tracks, passing tracks or main line.

For an inventory item such as lumber, which could be used for different purposes, the account distribution is assigned in the accounting department just prior to processing by the machine department.



The Minneapolis & St. Louis Railway Company

MATERIAL REQUISITION № 101079

ISSUE 21 ✓
RETURN 22
Requesting Area Marshalltown Car Shop Area No. 23032
Shipped from or Returned to Marshalltown Store Inventory Location No. 509
Date Filled or Returned 12 10 25

Stock Number Class	Item	Description	Unit of Issue	Quantity	Function or Work Order	Joint Facility or O C & I Reference
21	6750	OC.174 7/8x1' Cap screw	Ea	25	1 294	
21	6457	3/8" Flange Union N-3201	Ea	3	1 294	
76	2050	3/4" Roofing Nails	LB	4	3 475	
23	1596	5/16x1 1/2x12 1/2x12 1/2				
23	1345					

Shipping Instructions
Requested by

The Minneapolis & St. Louis Railway Company

MATERIAL TRANSFER № 51478

Date Transferred 12 10 57
24 Deliver Material to Section #1 Cedar Lake 101
25 Transfer Material from Storekeeper Marshalltown 509

Stock Number Class	Item	Description	Unit of Issue	Quantity Ordered	Quantity Transferred
50	9227	Shovel Round Point SH	Ea	1	1
45	5305	M16055 Lining	Ea	1	1
50	9170	Measure Tape 50 ft	Ea	1	1
60	0060				
60	4732				
60	5120				
60	5135				
72	6115				

Shipping Instructions
Requested by
Approved by

The Minneapolis & St. Louis Railway Company

MATERIAL USAGE AND RECOVERY REPORT № 27031

Location Name Cedar Lake Sec #1 Inventory Location No 101
Area No. 32141 Period Beginning 11 26 57 Period Ending 12 25 57

Source 21 MATERIAL USED

Item Description	Stock Number Class	Item	Unit of Issue	Quantity	Function or Work Order	Joint Facility or O C & I Reference
M16055 Lining	45	5305	Ea	1	3 488	
Measure Tape 50 ft	50	9170	Ea	1	3 501	
Shovel Rd point SH	50	9227	Ea	1	3 501	
Rail 100# SH	57	1045	FT	1250	8175	WO
Rail 85# SH	57	1035	FT			

Source 23 **USABLE MATERIAL RECOVERED OR SCRAP**

Item Description	Stock Number Class	Item	Unit of Issue	Quantity	Function or Work Order	Joint Facility or O C & I Reference
Rail 85# SH	57	2045	FT	900	8175	WO
Rail 85# Scrap	57	2045	FT	350	8175	WO
Rail 85# Scrap	57	2945	FT	420	5 421	
Frog 85# LH 7 ft.	58	0058	EA	1	4 429	
Rail Guard 100 SH	59	7186	EA	2	4 429	
Point Sw 85# RH SH	60	5121	Ea	1	8175	WO
Point Sw 85# LH SH	60	5136	Ea	1	8175	WO
Bar Angle 100 SH	62	0051	Ea	40	8175	WO
Bar Angle 85# SH	62	0037	Ea	10	4 429	

Fig. 2. — These are samples of forms prepared each month by each section foreman responsible for a particular inventory location. The form labeled « Usable Material Recovered or Scrap » appears on the reverse side of the « Material Usage and Recovery Report ».

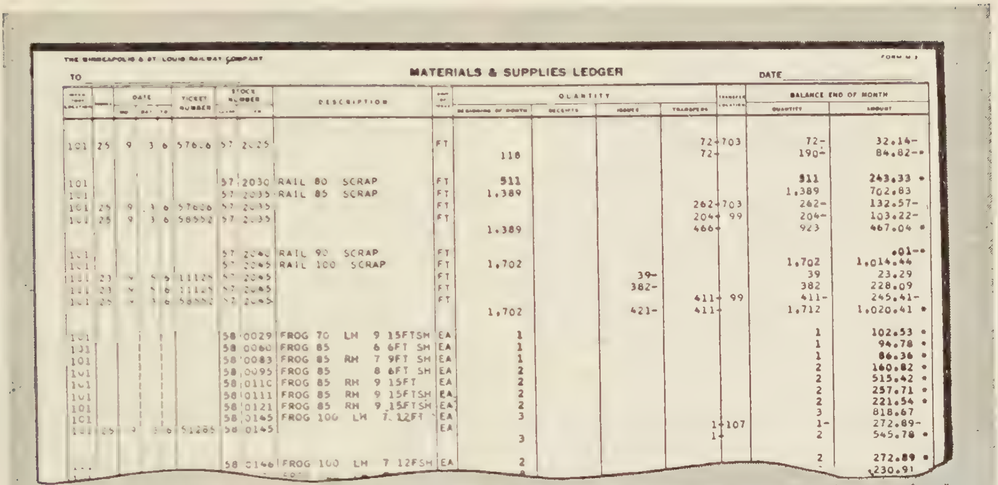
Use work order for AFE's.

If the material used is for a capital project, designation is made on the usage report of a specific work order number instead of an account.

Store-loading expense is calculated on a flat percentage to all material usage by the use of a 604 calculator, and follows the same distribution as the actual material.

The material transactions are then listed in material distribution journals for subsequent processing in the monthly general accounting records.

Material transaction cards, plus the material receipt cards, are then combined



THE MINNEAPOLIS & ST. LOUIS RAILWAY COMPANY

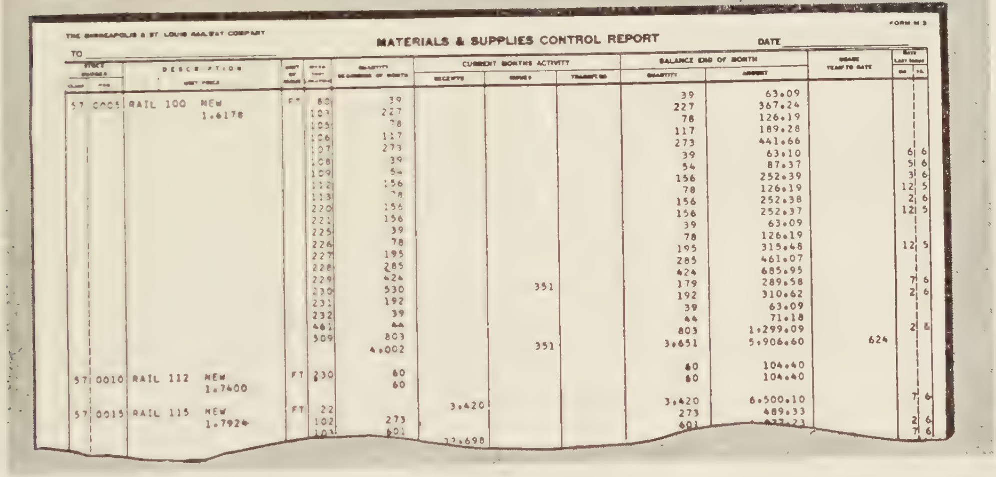
FORM M 2

MATERIALS & SUPPLIES LEDGER

TO ______ DATE ______

		DATE			TICKET NUMBER	STOCK NUMBER	DESCRIPTION		QUANTITY				TRANSFER LOCATION	BALANCE END OF MONTH	
		MO	DAY	YR					BEGINNING OF MONTH	RECEIPTS	ISSUES	TRANSFERS		QUANTITY	AMOUNT
101	25	9	3	6	57626	57 2025		FT				72	703	72-	32.14-
									118			72		190-	84.82-*
101						57 2030	RAIL 80 SCRAP	FT	511					511	243.33 *
101						57 2035	RAIL 85 SCRAP	FT	1,389					1,389	702.83
101	25	9	3	6	57626	57 2035		FT				262	703	262-	132.57-
101	25	9	3	6	58552	57 2035		FT				204	99	204-	103.22-
									1,389			466		923	467.04 *
101						57 2040	RAIL 90 SCRAP	FT							.01-*
101						57 2045	RAIL 100 SCRAP	FT	1,702					1,702	1,014.44
101	23	9	5	6	11125	57 2045		FT			39-			39	23.29
101	23	9	5	6	11125	57 2045		FT			382-			382	228.09
101	25	9	3	6	58552	57 2045		FT				411	99	411-	245.41-
									1,702		421-	411		1,712	1,020.41 *
101						58 0029	FROG 70 LH 9 15FTSH	EA	1					1	102.53 *
101						58 0060	FROG 85 6 6FT SH	EA	1					1	94.78 *
101						58 0083	FROG 85 RH 7 9FT SH	EA	1					1	86.36 *
101						58 0095	FROG 85 8 6FT SH	EA	2					2	160.82 *
101						58 0110	FROG 85 RH 9 15FT	EA	2					2	515.42 *
101						58 0111	FROG 85 RH 9 15FTSH	EA	2					2	257.71 *
101						58 0121	FROG 85 RH 9 15FTSH	EA	2					2	221.54 *
101						58 0145	FROG 100 LH 7 12FT	EA	3					3	818.67
101	25	9	3	6	51265	58 0145		EA				1	107	1-	272.89-
									3			1		2	545.78 *
...						58 0146	FROG 100 LH 7 12FSH	EA	2					2	272.89 *
															230.91

EXHIBIT 3—Prepared monthly, this ledger shows the balance at the beginning of the month of each item, receipts, issues and transfers and the balance at the end of the month.



THE MINNEAPOLIS & ST. LOUIS RAILWAY COMPANY

FORM M 3

MATERIALS & SUPPLIES CONTROL REPORT

TO ______ DATE ______

STOCK NUMBER		DESCRIPTION			QUANTITY	CURRENT MONTHS ACTIVITY			BALANCE END OF MONTH		USAGE YEAR TO DATE	DATE LAST ISSUE	
		UNIT PRICE			BEGINNING OF MONTH	RECEIPTS	ISSUES	TRANSFERS	QUANTITY	AMOUNT			
57	0005	RAIL 100 NEW 1.6178	FT	80	39				39	63.09			
				103	227				227	367.24			
				105	78				78	126.19			
				106	117				117	189.28			
				107	273				273	441.66			
				108	39				39	63.10		6	6
				109	54				54	87.37		5	6
				112	156				156	252.39		3	6
				113	78				78	126.19		12	5
				220	156				156	252.38		2	6
				221	156				156	252.37		12	5
				225	39				39	63.09			
				226	78				78	126.19			
				227	195				195	315.48		12	5
				228	285				285	461.07			
				229	424				424	685.95			
				230	530		351		179	289.58		7	6
				231	192				192	310.62		2	6
				232	39				39	63.09			
				461	44				44	71.18			
				509	803				803	1,299.09		2	[illegible]
					4,002		351		3,651	5,906.60	624		
57	0010	RAIL 112 NEW 1.7400	FT	230	60				60	104.40			
					60				60	104.40			
57	0015	RAIL 115 NEW 1.7924	FT	22		3,420			3,420	6,500.10		7	6
				102	273				273	489.33		2	6
				103	601				601	[illegible]		7	6
						22,698							

Fig. 4. — This report shows the quantity of specific items at each location on the system. Information shown includes usage year to date, date of last issue, and system average.

and sorted by stock numbers and location. The balance of each item at the beginning of the month is added, and a materials and supplies ledger is prepared by inventory location (fig. 3). This ledger shows the balance at the beginning of the month of each item, receipts, issues and transfers and the balance at the end of the month.

MONTHLY REPORTS ON MATERIAL TRANSACTIONS ARE PROCESSED TO GIVE CONTROL DATA.

The cards are then resorted by individual items for all locations and a materials and supplies control report is prepared (fig. 4). This report shows the quantity of a specific item at each location systemwide. Among other things it includes usage year to date, date of last issue, system average and a summary of the current month's activities by location.

Next, a location summary is prepared. This shows the total dollar value of inventory by location as compared to the previous month. Next, a class summary is prepared. It shows the dollar value of each class of inventory, comparing the balance with the previous month's balances.

After these reports are prepared, new system balance cards are prepared and a new system average price is calculated, at which time a comparative price report is prepared. This comparative price report compares the prior month's system price with the new system average price. It is used principally to detect any errors that may creep in from miscoding or erroneous inventory prices.

Material usage reports are cut off at the 25th of each month. By the 10th of the following month the reports are issued to the operating department and to each person responsible for a portion of the inventory.

Ties handled differently.

Tie inventory controls present a special problem. Ties are generally purchased green or dry and are subsequently treated and then shipped to the railroad. A special control account is used to charge the cost of green ties, freight and treating costs. When the ties are shipped from the treating plant to the railroad, transfer tickets are prepared to transfer the ties from the control account to the mechanized inventory control procedures. These same procedures are used for treated bridge lumber and piling.

One month prior to the date for physical inventories, a machine listing is prepared on the last recorded items at a particular inventory location. This is a double-spaced listing giving the stock number, unit of issue and a description of each item.

The individual taking the inventory then merely inserts the quantity count in an appropriate column. The only requirement for additional writing is in the case of an improperly described item of inventory, or where a new item is inventoried which was not previously carried in the inventory balance.

After the physical counts are made, the sheets are returned to the accounting department where the stock number, quantities, and locations are keypunched. Price cards are collated into the inventory count cards and the appropriate dollar extensions are made mechanically by the 604 calculator.

After the extensions are made, the new physical inventory is matched item for item against the book balance and a listing is made of the differences, quantity and dollars. Any large discrepancies are then investigated and the appropriate adjustments are made to correct the book balances to the physical.

Periodically, a detailed listing is made of all inventory items which have not shown movement for a certain period of time. This listing is then used for purposes of either selling or scrapping the inventory if it is obsolete, unusable or surplus.

We are currently developing a maximum-minimum system which will show shortages or excesses in authorized stock. This can be done merely by establishing minimums and maximums for the desired items at the desired locations, and sorting or matching these minimums and maximums against the quantities on hand at the end of a given period.

Not a daily balance.

As mentioned above, the inventory reports are issued approximately 10 days to two weeks after the close of a particular accounting period. Accordingly, day-to-day inventory balances are not available for the purchasing and stores department. We have found for track material that this is not important. But, for Diesel locomotive parts it has presented a problem and several records must be maintained on fast-moving parts. Under our procedure it does not appear to be practical to try to develop a day-to-day control. It would appear that this could only be performed by using a high-speed computer, and the additional cost does not appear to justify such an expenditure at this time.

[625 .143 .4 (73)]

« Glued » rail . . .

A progress report on the newest method of « freezing » rail joints.

(*Railway Track and Structures*, January 1958.)

A revolutionary method of « freezing » a mechanical rail joint into an immobile unit is now being tested on several railroads. Developed by the American Railroad Curvelining Corporation, this method makes use of resin plastic adhesives, known as Bondarc, which were specially developed for American Railroad Curvelining by the Armstrong Cork Company.

Preliminary tests are reported to indicate that this method of creating a smooth continuous rail can add from 10 to 15 years of life to an existing track because it eliminates battered rail ends. Also, the « glued-track » is expected to solve maintenance problems caused by the expansion and contraction of mechanical joints. It is pointed out that failures of the adhesives, which have been quite rare and which can be traced to faulty installation, result in no loss of security because the adhesive is applied in existing mechanical joints.

Bondarc is one of a family of adhesives which depends on molecular bonds developing between the material being adhered and the adhesive itself. The area of contact is considered vital to the creation of a strong bond to ensure maximum resistance to slippage. Since the material is strongest in shear, it was believed that existing rail joints would provide a satisfactory assembly for testing, and would assure safe operation should the glue fail in a joint.

More than a year of laboratory research was conducted, first at the Armstrong Research and Development Center and the testing laboratories of the Bethlehem Steel Corporation, and later at the Fritz Engineering Laboratories at Lehigh University. Specimen joint assemblies of RE 132-lb. rail with new 36-in. RAJO 6-hole joint bars were furnished for these tests by the Rail Joint Company.

Laboratory tests are reported to indicate that at least 300 000 lb. resistance to slippage could be expected from a joint where Bondarc was applied to the clean sand-blasted fishing surfaces of the rail and bars. It is said that an additional 40 000 lb. could be obtained, if required, by butt-gluing the rail ends as well. Extreme cold had no effect on the glue itself, although this condition would be likely to present the most adverse tension effects in the track. Experiments using various bolt tensions indicated that tensions greater than 20 000 lb. were not required, precluding the necessity of using high-tensile-strength bolts.

Positive and negative deflection tests

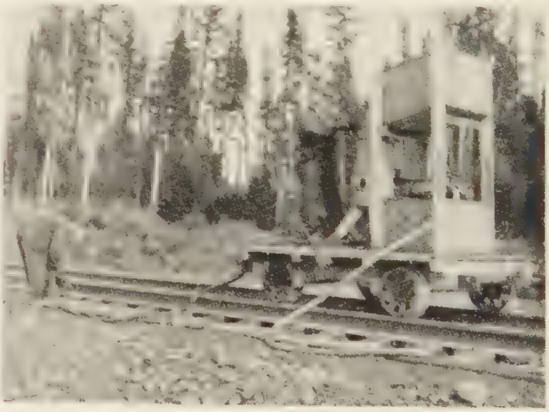


Fig. 1. — After joint bars had been removed and the gaps closed with an expander the bars and sides of the rail ends were cleaned by sand blasting.

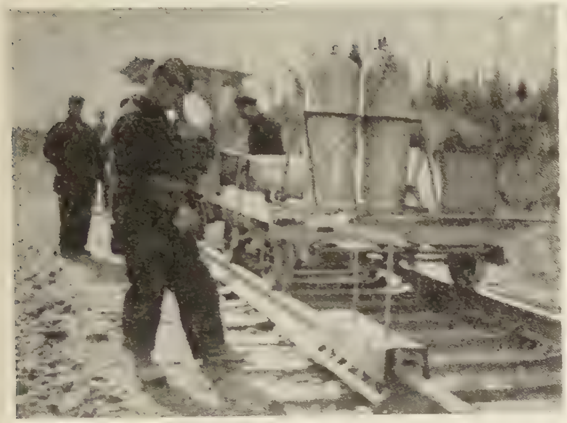


Fig. 2. — Angle bars for each joint were stacked on rail ends and the assembly preheated by a propane-fired oven suspended from a push car.

were conducted to determine the influence of a load centered at the gap and the deflection under a 400 000-in.-lb. bending moment. Afterwards, the same joints were slip-tested and it was found that the slip characteristics had not been affected by the deflection.

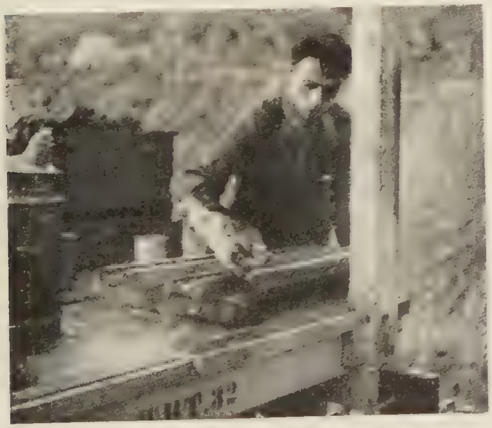


Fig. 3. — Using push car as work table man applies adhesive to bars with rubber glove. « Glue » used is a two-part resin plastic adhesive.

Amsler alternating load tests, with loads of 44 000 lb. positive and 22 000 lb. negative being applied, gave bending moments of plus 400 000 in.-lb. and minus 200 000 in.-lb., respectively. Again the joints were separated, one after 800 000 cycles and the other after 1 million cycles, revealing, it is reported, that vibration was not likely to cause failure in the glue, although cleavage at the rail ends might be a problem. It was felt the results of the laboratory tests were adequate to justify in-track installations.

During the first week of August 1957, a mile of glued track was laid on the Delaware & Hudson near Schenevus, N. Y., as part of its regular « frozen-joint » rail-laying program. The glued track consists of new 115-lb. rail laid with Rail Joint head-free bars.

Since regular frozen joints have been laid on both sides of this stretch, there is an opportunity for comparison. Various difficulties encountered in adapting the laboratory technique for making glued joints to field practice were overcome during the laying of the first side. For purposes of test, this side is therefore being discounted. The second side is considered the test rail. To date, only 4 of the 135 joints have had glue failures and these fractures were anticipated due to faulty application. Experience with this stretch is reported to have revealed that, once the glue has completely set approximately 20 min after installation, bolt tension becomes unimportant to the effectiveness of the glued joint.

In September 1957 two miles of used rail were converted to continuous glued track on the Quebec, North Shore & Labrador. This location was chosen for test because the coldest winter temperature registered last year was — 70 deg. F. In addition, this installation is daily subjected to 20 trains per day or approximately two million gross tons per month. The installation was made under these traffic conditions. This forced a complete re-vamping and streamlining of the technique used on the Delaware & Hudson.

Representatives of American Railroad Curvelining say their experience indicates that the techniques of applying Bondarc, while having basic requirements, must be adapted to fit the individual circumstances of each installation. It is a two-part adhesive in which a hardener (Part B) is added to the base material (Part A). One basic requirement is that the gluing areas must be free of mill scale and rust. Another is the pre-heating of both the joints and rail to help eliminate stressing the adhesive during the interval between the « jell » and « cure ». A third is post-heating the joint assembly after application in order to hasten the « cure ». Because of the two-part nature of the adhesive it is not advisable to pre-mix large quantities because the time available to apply the mixture is limited.

In the field, the temperature and length of time before Bondarc gels or takes its initial set are entirely dependent on temperature, both atmospheric and rail. Atmospheric temperature controls the « pot life » of the mixed Bondarc while the rail temperature determines the gelling and curing or hardening time. The temperature curve for Bondarc is non-linear; thus field methods can be tailored to local working conditions.

On the Delaware & Hudson, the installation of glued joints was done in conjunction with the actual rail-laying operation in double-track territory. Thus long cure times could be tolerated, since traffic was detoured all day. This permitted elimination of the post-heat operation. Alternatively, the pre-heat operation might have been eliminated instead, had this been known at the time. The method used on the QNS & L is shown below.

It is emphasized by ARC representatives that, while the development of Bondarc is not yet complete, they expect the results of these initial installations to pave the way for more widespread trials throughout the industry.

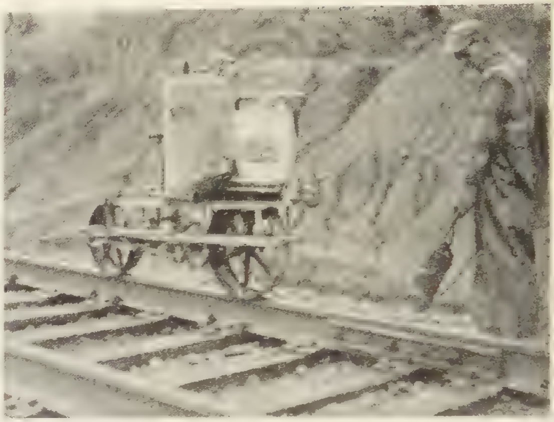


Fig. 4. — Re-assembled joints were post-heated to hasten the « cure », using kerosene torches.

This is how the joints were « glued » on the QNS & L.

On the QNS & L two basic methods of making « glued » joints were tried. On the first mile, the joint gaps in the rail in service were closed and the joints glued. On the second mile new rail and joint bars were used, which were glued out of service, 20 rails at a time, then installed in the track. Both methods were tried because of the long traffic delays.

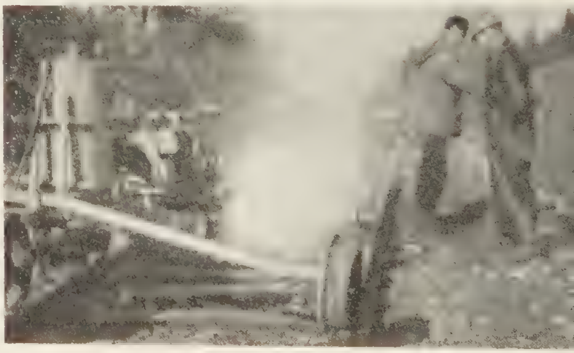


Fig. 5. — If train should pass before « cure » was complete, the joint was cooled with water spray to stop the reaction.

Where the work was done in track the joint bars were removed and the bars and rail-end sides were sand-blasted, using a special sand-blasting machine mounted on a push car and supplied with air from a 375-cfm compressor through a 1 000-ft. hose provided with outlets every 50 ft. This compressor, while equipped for on-track operation, was operated from a setoff and moved every 2 000 ft. as gluing progressed. (On the D & H, the dead track permitted on-track operation of a smaller compressor). A fine dust-free abrasive proved the best sandblast material since it cut rust quickly and left no dust film residue. Dried, screened local sand was also tried with moderate success but the surfaces to be glued had to be wiped clean with a solvent for good glue adhesion.

Following the sand-blasting, the joint bars were stacked on top of the rail and the joint area pre-heated in a propane-fired portable oven, suspended from a push-car. By preheating, the glue was easily applied, the gel time was long enough to permit thorough assembly of the joint, and the heating time to cure was considerably reduced.

The glue car was a push-car work table on which the glue was mixed and applied to the warm bars. Solvent was available for wiping the bars clean and for clean-up. Initially, the glue was applied to the bars with an air-driven, cartridge-type caulking gun, but later it was found that a man using rubber gloves could apply it quicker with his finger since the preheated bars softened the glue to the consistency of melted butter.

The re-assembled joint was again heated, using two modified hand-held kerosene torches supplied from a common tank. In the event of traffic coming before the cure was complete, the joint was cooled with water spray to stop the reaction.

[656 .1]

Keeping track of buses.

Scanning unit tells control centre where vehicles are.

(*Engineering*, January 10, 1958.)

At first sight, finding a bus in a city is not so difficult as finding a needle in a haystack. Buses are conspicuous. But to devise an economical system that will allow a central operator to know the position of each of a fleet of buses calls for considerable ingenuity. The proverbial needle can be quickly picked out, using a magnet. Buses too can be located magnetically; and by television; and by radio communication. Yet when some 7 000 buses are involved, on about 500 routes, such methods become too costly to be practical.

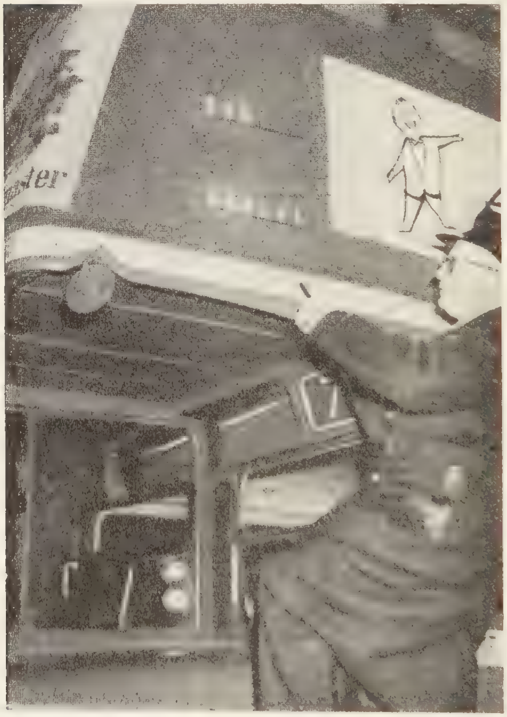


Fig. 1. — The identification plate on the bus carries « cats eyes » reflectors. In this view the lower set of reflectors is the timing base.

Lack of knowledge where buses are at any instant of time is the main difficulty in operating a regular bus service through congested city streets. To overcome it, London Transport have developed a system that tells them when a particular bus passes selected points on its route. Electronic equipment at each point reads the bus numbers as they pass. Having obtained the number, the equipment transmits it over telephone wires to a central office. There it is displayed on an illuminated panel.

London Transport will fit reflecting « cats eyes » on the sides of their 7 000 buses. The reflectors serve to identify the bus for the Bus Electronic Scanning Indicator — recently tried out in service on the No. 74 bus route. A variety of schemes were tried, including magnetic scanning and radio communication, but the optical method proved to be best. It is still in the primary development stage but improvements in service are confidently expected from it. Figure 1 shows the way the cats eyes are fitted.

Each bus running number is put into binary code. This is reproduced on a plate that has a reflector for each digit and a corresponding blank for each zero. The plate fits into slots and is easily changed. It is placed on the nearside of the bus towards the front, above the driver's cab. At selected points on the route, scanning equipment is erected at the same height as the bus plate and as near as possible to the roadway — either on a post at the kerb or, where the pavement is narrow, on a building. The equipment focuses a beam of light on the bus plate and detects

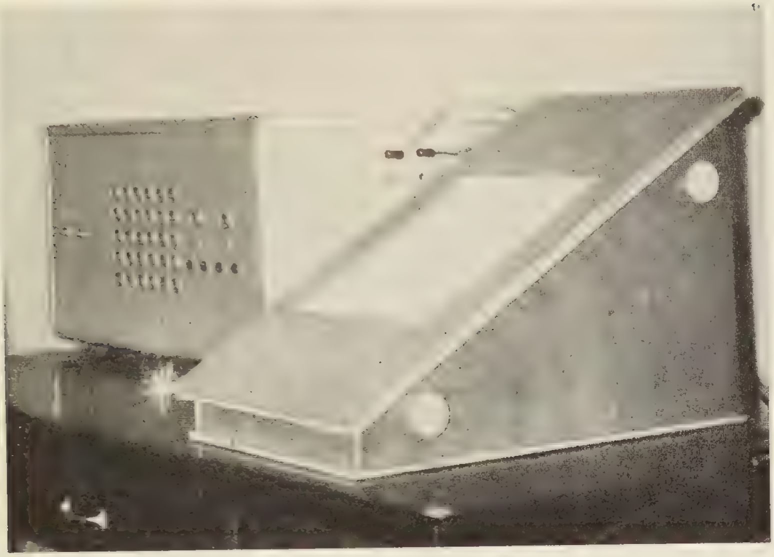


Fig. 2. — Each check point on the bus route has a display panel. As a bus passes the check point its number lights up on the panel.

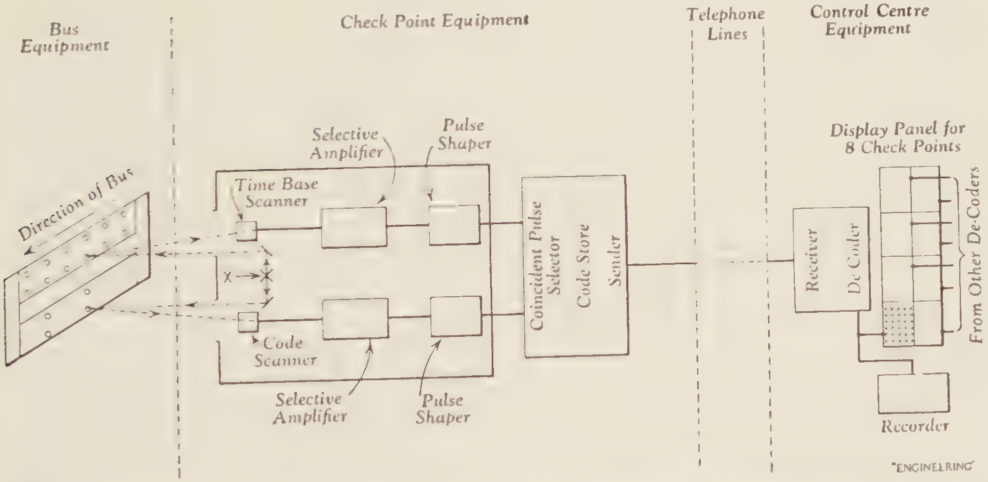


Fig. 3. — The general diagram of the Bus Electronic Scanning Indicator, which will allow London Transport to keep track of their buses as they pass through London.

the reflected light by a photo-transistor. Each reflector gives rise to a pulse of current through the transistor and the string of reflectors produces a train of pulses as the bus passes the scanner. In fact, the current pulses will be the binary code representation of the bus number.

This way of identifying buses raises several problems. Buses are moving at various speeds, perhaps accelerating, past the check point. The actual height of the identification plate will vary with different passenger loads and positions of the bus on the road camber. Interfering light from external sources will enter the photo-transistor whether a bus is present or not. All these problems call for a solution that is both simple and economic.

To allow for different heights and camber, the reflectors are arranged in pairs, one above the other, at 1 in. centres. To compensate for varying speeds, the plate is produced in two parts. The upper half has a complete row of reflectors that forms a timing base — there is also an additional reflector at the end to act as a clear down unit. The lower half, put 10 in. below the timing base and exactly in line with it, carries the binary code. The horizontal spacing of 2 in. has been found satisfactory for speeds up to at least 40 m.p.h. The reflectors are $^5/_8$ in. diameter and are designed for a narrow reflecting field. They have very low scatter.

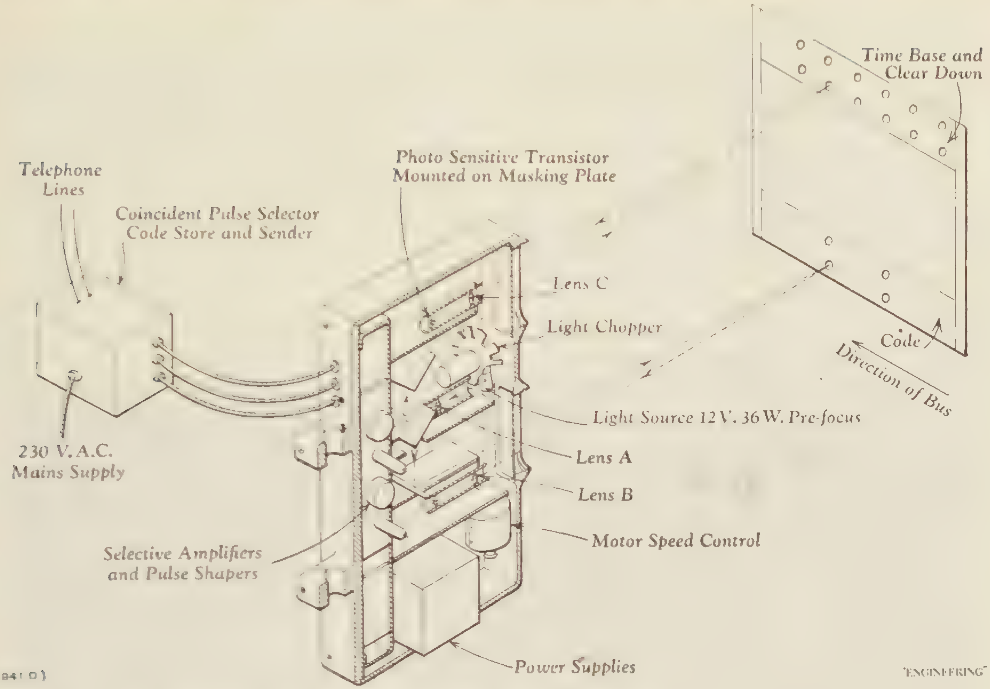
The problem of interference is overcome by giving the light from the scanner an identifying characteristic that will not be present in any other light sources. It is switched on and off 3 000 times a second. The identifying frequency can not be confused with the frequency with which the reflectors return the light as they pass the equipment. For, if the bus is moving at 30 m.p.h., a line of reflectors spaced 2 in. apart horizontally will produce pulses at a rate of 264 c/s — a frequency sufficiently far below 3 000 c/s to avoid confusion. Once the incoming light signals are converted to pulses of electric current by the photo-transistor it is possible to reject all extraneous signals that do not bear the identifying frequency.

Figure 2 shows the display panel that is linked to one check point. Each lamp on the panel carries the number of a bus. As a bus passes the check point linked to the panel the corresponding lamp lights. With several panels in the same room it is possible to locate any particular bus by noting the last check point that it passed. The characteristics of the final relays controlling the panel lamps are such that if two lamps are in circuit at the same time, as when a bus passes from one scanning zone to another, the current demand causes the voltage to drop and the light on the first panel is extinguished in favour of the one on the following panel.

A general diagram of B.E.S.I. is shown in figure 3. The telephone lines linking the check point equipment to the control centre will be for the most part London Transport private lines, notably those on their railway system. Otherwise the lines to the scanning points would be the largest financial obstacle to the scheme.

At each check point a scanning equipment must be installed at each side of the road to register the flow of buses. Moreover, the scanner unit must be mounted so that the buses pass within about 12 ft. of it — above this distance the angular displacement of the light becomes increasingly difficult to accommodate. In addition, if the spacing from the kerb becomes too great, there is the danger of a parked lorry completely masking the scanner. Sites chosen, therefore, are places where the road is narrow, or its width restricted due to a pedestrian island. As the scanner unit itself may need to be pole mounted, it has been made as small and as light as possible. When it is mounted in this manner the relays and other equipment must be mounted at suitable positions as near as possible, either in a building or in a street box on the pavement.

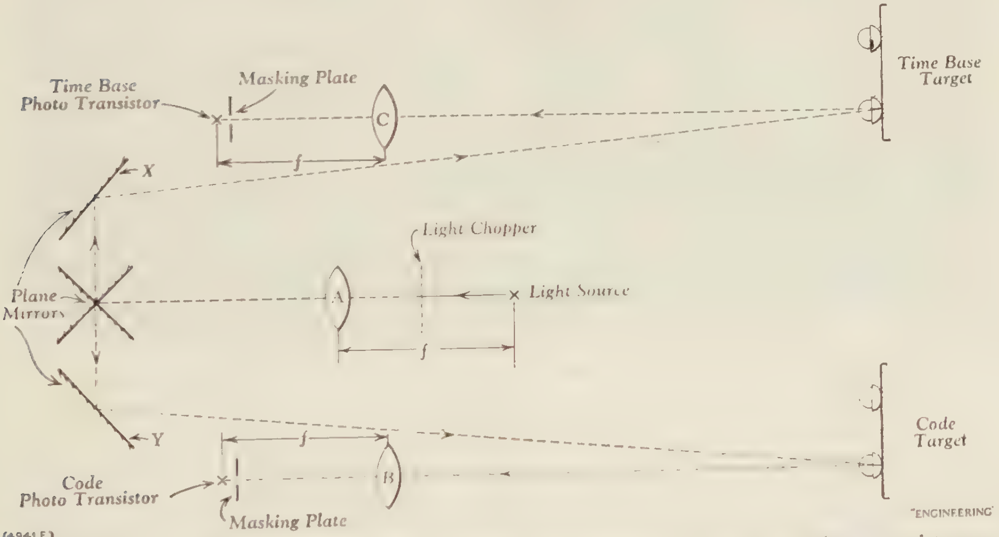
Figure 4 is a diagram of the scanning unit. It will be seen that only one lamp


Time Base and Clear Down
Telephone Lines
Photo Sensitive Transistor Mounted on Masking Plate
Coincident Pulse Selector Code Store and Sender
Lens C
Light Chopper
Code
Direction of Bus
Light Source 12 V. 36 W. Pre-focus
230 V.A.C. Mains Supply
Lens A
Lens B
Motor Speed Control
Selective Amplifiers and Pulse Shapers
Power Supplies

(4941 D)

"ENGINEERING"

Fig. 4. — The scanning unit contains a single lamp whose beam is interrupted by slots on a rotating disc. Mirrors split the beam into two.



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(4941 E)

Fig. 5. — The simple optical system operates in conjunction with two photo-transistors : one for the code target, the other for the time base.

is used and the two beams, for time-base and code number, are obtained by a system of mirrors — shown in figure 5. The 3 000 c/s identification is impressed by passing the light through the peripheral slots of a rotating disc.

The light reflected from the bus plates is passed into the scanner once more and focused on to two photo-sensitive transistors. These transform the light impulses into electrical impulses. The electrical signals enter frequency selective amplifiers that reject impulses due to extraneous light not associated with that of the instrument's lamp at the controlled frequency. Then, as the waveform of the 3 000 c/s signal impressed with the bus identification code cannot operate the telephone relays in the equipment that follows, the signals from the amplifiers are passed through pulse-shaping transformers that give a square pulse from each reflector signal. The pulses from the time-base plate are then paired with those of the code plate by feeding them to cold-cathode valves, and when both time-base and code valves fire together, relays are operated and the code is stored.

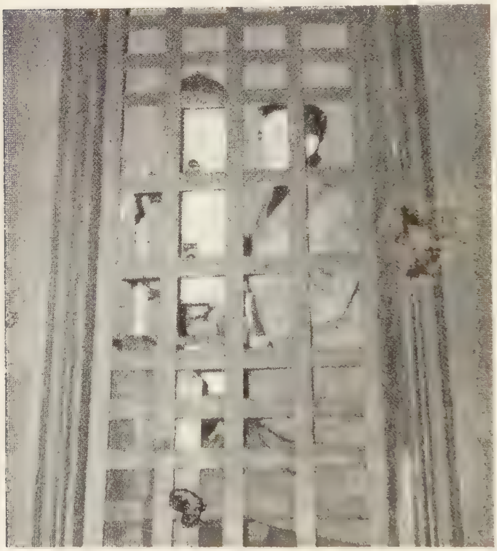


Fig. 6. — The two apertures through which the two beams are projected and reflected back can be seen in this view of an installed unit.

Storing is necessary: for at least two scanners — and may be more in busy traffic centres — have to share the telephone line to the control centre. The relays storing the code are released in turn over the line, giving pulses similar to those associated with the dialling of a normal telephone. There is little technical novelty in the circuit used at the control centre. The stored binary number at the scanning point is fed into the line, as soon as a clear channel is available, by normal pulsing procedure.

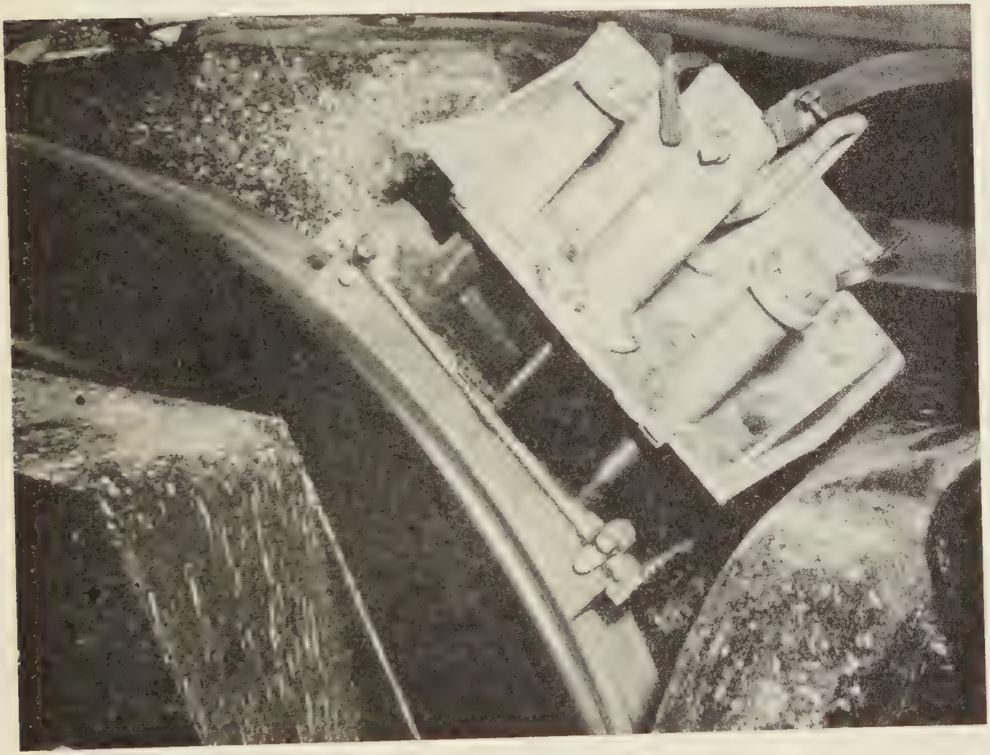
The pulses are stored in a similar manner by relays at the centre and, when built up, energise the lamp carrying the running number corresponding to the code. In addition, a pen recorder can form a permanent record of the time each bus enters the section and hence indicate the regularity of service. The whole of the equipment has been designed and developed at the London Transport Executive's Electrical Testing Section at Wood-lane, London, W. 12, under the direction of Mr. T. S. Pick, the Chief Electrical Engineer.

[625 .143 (73)]

Rail treatment pays big returns.

What the Reading achieved : Tonnage per train — up 16.4%.
Cars per train — up 14%.
Trains needed to handle traffic — down 14%.
Locomotives needed — down 4.7%.

(*Railway Age*, January 6, 1958.)



Adhesion shoe and mechanism for applying antilubricant to a wheel in lab tests.

Rail conditioning to improve adhesion was initiated on the Reading three years ago. Tests in 1956 showed that where conditioning is needed, tonnages may be increased as much as 17 %. It is estimated that under such conditions average net savings over the cost of application may come to 25 to 40 cents per train-mile.

More recent tests involving new materials and improved methods of application are reported in a paper presented at the Railroad Division meeting of the American

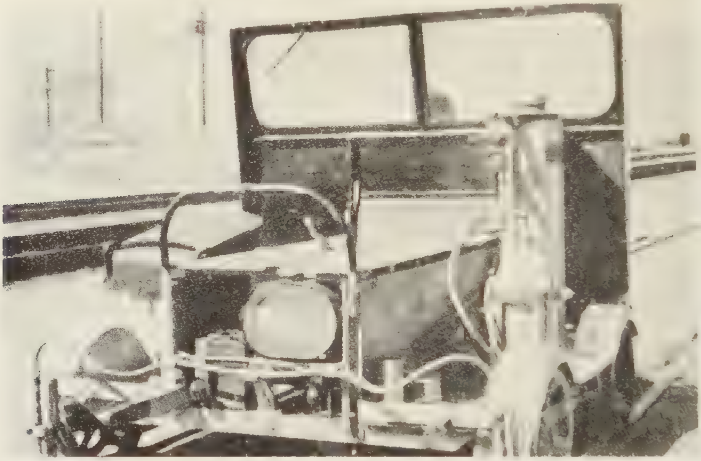
Society of Mechanical Engineers in New York, December 1-6, by F. G. Fisher of the Reading, R. F Allen of General Electric Company and G. W. Luvisi of National Aluminate Corporation.

The ideal method of applying the conditioner would be from the front of the locomotive, but so far this has not proved practicable, since some time is required for the conditioner to do its work. Other methods include application from the caboose or a trailing locomotive to serve following trains and from a rail car to prepare the rails in advance of train movements. Up to the present, the latter method has proved most effective. A rail car and trailer have been devised for this purpose.

Results from the use of this equipment show that rail conditioning increased tonnage per train 16.4 % and cars per train 14 %. Consequently, traffic was handled with 14 % fewer trains and 4.7 % fewer locomotives than would have been required without rail conditioning.

The ultimate goal of this program, the authors of this paper report, is the development of a rail conditioning formulation capable (1) of being applied from the locomotive; (2) of giving peak adhesion values of 25 % regardless of rail contamination or weather; (3) of functioning without more than an occasional light application of sand under particularly adverse conditions.

Progress toward this goal must be guided by sound economic considerations or the cure may prove worse than the disease.



Chemicals are applied to rails with this motor car on the Southern Pacific.

Results of field applications and observations lead the authors to conclude :

1. Best results are obtained when Nalco RC is applied ahead of each train. At least one spraying for every three trains appears necessary;

2. The results of spraying are cumulative, and best results under adverse weather conditions are obtained when the rail has been conditioned for at least a week;

3. The number of sprayings and the dosage depend upon rail conditions. Possibly, either the frequency of spraying or the dosage may be reduced after the rail has been conditioned for a period of time;

4. Motor car application is practical where operating conditions and traffic permit its use;

5. Application from a pusher locomotive or caboose to condition the rail for succeeding trains holds some promise. In this case, conditioning should be started and stopped automatically by roadside equipment at the proper points;

6. Results from one year of testing indicate attractive savings. The cost of rail conditioning with the motor-car train amounts to 28.2 cents per train-mile. The estimated net annual saving, based on handling the same volume of tonnage over a 106-mile division, (including a 0.6 %, 34-mile grade), amounts to 17.5 cents per train-mile;

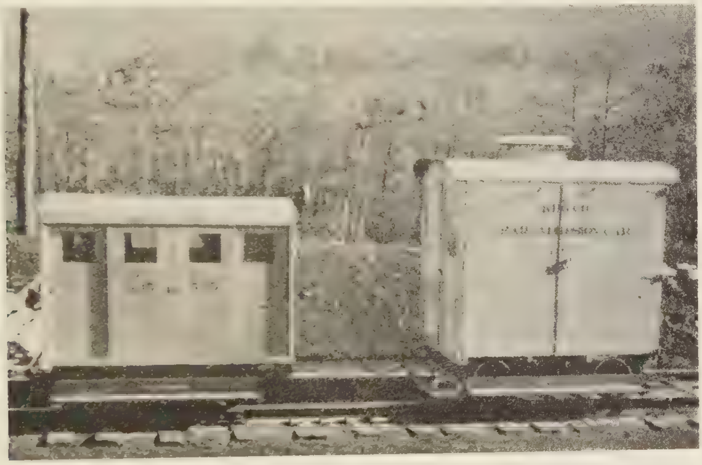
7. Future developments should be aimed at providing rail conditioning through the application of a chemical formulation at the lowest cost per train-mile, and a minimum of 21 % adhesion regardless of weather, providing all adverse rail conditions other than surface contamination have been corrected.

New adhesion studies.

A theoretical discussion of the reasons for variable wheel to rail adhesion, together with some suggestions for its control and improvement, were included in a paper presented at the same meeting by Spiro Kyropoulos of Holloman Air Development Center, Alamagordo, N. M. Factors affecting adhesion, he said, are thin layers of oxide on the rail and the addition in varying quantities of adsorbed water and oils.

Rail and wheel surfaces, this paper states, are covered at least with a layer of oxide and perhaps in addition with an adsorbed layer of water, depending on the relative humidity of the atmosphere. These layers stay on the contacting surfaces no matter how high the contact pressures. The same applies to oil on the rail. In the case of leaves, vegetable oil may be involved and certainly some hydrodynamic lubrication.

One suggested method for improving adhesion is to apply wipers ahead of a locomotive — the foremost being dry and one or two subsequent ones being moistened with a volatile solvent such as hexane-



Rail and push car operate at 20 m.p.h. on tangent track and 15 m.p.h. on severe curves.

methylalcohol or acetone-benzene capable of dissolving films of both oil and water.

Adhesion increases when the contact surfaces are subjected to electrolytic action. The authors suggest that a brush could be brought in contact with the inside of the wheel rim so that the wheel and rail form one electrode. The second electrode would consist of a brush soaked with an electrolyte applied to the rail and the outer edge of the wheel rim. With voltage supplied by a small battery, it is thought this would improve adhesion by the removal of the oxide.

A third suggestion is that chemically inert, water-soluble drying agents, such as anhydrous sodium sulphate, might yield most benefits of hard abrasives such as sand without their disadvantage. Being water-soluble they would not contaminate track ballast.

Southern Pacific tests.

Much work on means of improving rail adhesion has been done by the Southern Pacific in collaboration with the Battelle Memorial Institute and Stanford Research Institute. Information gained from laboratory and field work was summarized in another paper at the ASME meeting, by P. V. Garin of that railroad.

Mr. Garin reports that from an economic viewpoint, some form of silica is the most effective means for increasing adhesion between driving wheel and rail. Particle size is unimportant, since high rail pressures reduce any sand or other form of silica to an extremely fine powder. Very little sand is better than a lot, if it can be applied where it is needed.

In laboratory tests, thin water slurries and thick water-mixed paste gave acceptable increases in friction values. An adhesion shoe has been devised. It is similar to a brake shoe but is composed principally of silica and a binding material. It applies antilubricant to the wheel. The report states that if a suitable retracing device were designed, this method would be effective and would use a greatly reduced amount of antilubricant.

Favorable reports from the Swiss Federal Railways (*Railway Age*, December 24, 1956, p. 24) have indicated the practicability of brake control of wheelslip without sand.

The Southern Pacific is also making tests on chemical treatment of rail to improve adhesion. For this purpose, it has developed a car for applying the chemical. Unlike the two-car arrangement used by the Reading, the apparatus is all mounted on a single car. This was made possible by applying the chemical by means of compressed carbon dioxide instead of an air compressor.

Discussion indicated that the much desired high adhesion can be obtained practically by applying conditioner to specific stretches of track, but that some means of applying it from the locomotive is essential to general application.

[385 (06 .111]

Summaries adopted at the seventeenth Session of the International Railway Congress Association (Madrid, 1958).

1st SECTION. — Way and Works.

QUESTION 1.

Problems presented by the ageing of bridges and viaducts. Long term effects of fatigue and corrosion in steel bridges and weathering of masonry.

Rational methods of maintenance of bridges.

Repair and strengthening.

SUMMARIES.

« 1. It is not possible to foretell the « life of a bridge when building it solely « on experience acquired from observing « existing bridges.

« Best quality materials, the most « careful methods of calculation, and « new constructional methods lead us to « think that the life of new metal and « reinforced concrete bridges will be very « long, provided they are suitably main- « tained.

« The influence of the duration of life « of a bridge on the financial charges « which this involves is, in general, not « great, and the choice of a type of « structure to be decided upon is deter- « mined by more important considera- « tions.

« 2. Several Administrations fix the « budget allocations for maintenance « and renewal as a function of the total « value of the bridges; but most of them « determine these sums from the condi- « tion of the bridges and the experience « acquired, taking into account their « financial resources, which often makes « it impossible to carry out all the main- « tenance work which had become « necessary.

« 3. The progressive increase in the « loads generally makes it necessary to « check by calculation existing metal « bridges in order to decide if they can « take the new loads proposed.

« The opinions of the Administrations « differ as to the proper interpretation « of the technological tests which have « been carried out on elements from old « metal bridges. The stress limits al- « lowed for such bridges vary consider- « ably from one Railway to another.

« 4. To examine metal bridges the « Administrations generally make use of « sounding by hammer in the case of « rivetted assemblies, and measuring the « deflections and stresses as well as the « use of X rays to check the welds. « New processes, such as those based

« on ultrasonic equipment or magnetisa-« tion have already been given a trial on « several Railways.

« 5. While the opinions of the Admi-« nistrations varied concerning the in-« fluence of fatigue and ageing, it was « generally recognised that the observed « deterioration can be said to be due to « a number of causes, faulty design or « construction, and above all corrosion. « For good preservation of metal bridges « it is of primary importance to protect « them against the latter, which is most « likely to occur at those places which « are difficult of access, exposed to dirt « or smoke, insufficiently ventilated, or « likely to collect water.

« Consequently, when designing new « bridges, it is essential to select smooth, « simple designs, and adequate construc-« tional arrangements. This considera-« tion can lead in certain cases to pre-« ference being given to welded cons-« truction rather than rivetted construc-« tion. In addition bridges should be « given regular maintenance.

« 6. Careful painting and regular re-« painting, carried out after proper pre-« paration of the surfaces (hammering, « scraping with metal brushes, descaling « by sand jets or shot blasting, and « sometimes flame cleaning) are the « most currently used methods for pro-« tecting metal bridges against corrosion.

« For new structures it is generally « recommended to apply the first coat of « paint in the workshop after descaling « and cleaning.

« In general, the paint used is the « classic red lead, iron, or chromate of « zinc paint (undercoats) and white zinc, « white lead, iron oxide, and aluminium « paints, or those with a bitumastic or « tar base (protective paints).

« It is not yet possible to formulate « any valid opinions concerning the trials « made of special paints based on new « formulae (with a vinylitic resine base, « lead-metal, chlorated rubber, etc.) « which some railways have started to « use.

« 7. In the opinion of most of the « Administrations in the case of rivetted « structures, surfaces permanently in « contact should be protected by a coat « of paint.

« In the case of welded structures, on « the contrary, this practice may be « given up when the surfaces in contact « are assembled by continuous welds.

« In addition, it is recommended not « to cover these surfaces with paint « when high tensile bolts are used for « assembly.

« 8. Where local conditions are par-« ticularly unfavourable, it is necessary « to repaint every two years, whereas « intervals of 30 to 40 years between « repainting may be possible in certain « mountain districts where the air is pure « and dry.

« Partial repainting makes it possible « to increase the intervals between two « complete overhauls.

« 9. Methods of protecting metal « structures other than painting (metalli-« sation, cathodic protection, use of rust-« less steel and other metals or alloys) « have only been used in special cases.

« Encasing in concrete metal parts « exposed to the smoke from loco-

« motives is the current practice on certain Railways; in particular mention « must be made of the use of prefabricated concrete or asbestos cement « components, which are giving satisfaction.

« 10. Metal bridges are repaired « either by replacing damaged parts « when possible, or by reinforcing these « elements by adding new sections or « plates by rivetting, bolting or welding. « In cases like this, the advisability of « using welding is still queried.

« A number of Administrations consider that welding is a practical procedure, which facilitates the work of « strengthening structures. It must, however, be used with great care, particularly with wrought iron.

« 11. The all over reinforcement of « metal bridges can be obtained by « adding new elements, or by strengthening the sections of existing elements « or their assemblies.

« The majority of Administrations « prefer to renew bridges completely « rather than carry out large scale reinforcing operations, especially in the « case of old iron bridges.

« In the case of steel bridges, the « choice between building a new bridge « and reinforcing an existing bridge must « be settled by comparing the cost of « the different possible types, including « the supplementary or indirect costs, « and a conservative estimate of the life « of the reinforced bridge, together with « the expected maintenance costs, which « are generally higher in the case of a « reinforced bridge than a new bridge.

« 12. The construction of masonry « and concrete arched bridges must be « avoided when it does not appear possible to keep the pressure on the soil « within limits compatible with a wide « margin of safety.

« The success of reinforced concrete « bridges depends upon using good quality aggregates with suitable granular « structure. The water content should « not be too high. The arrangement « of the reinforcement metal must be « carefully studied and executed, and it « must be properly covered.

« 13. The condition of masonry and « concrete bridges is generally checked « by a visual inspection, noting any possible displacement of the reference « marks, inspecting test pieces, periodically checking the levels, sounding « the surface with a hammer; other special non-destructive methods have been « given trials, but it is difficult and « often expensive to get accurate information about the inner state of the « bridges.

« 14. Good preservation of masonry « and concrete bridges is only possible « if they are sufficiently watertight and « have effective drainage systems.

« Although it appears easier to realise these conditions in cases of bridges « constructed in longitudinally and transversely pre-stressed concrete, as well « as bridges on which the track is laid « directly on the concrete without ballast, and where the water quickly « drains away, in certain of these cases, « as well as the majority of other cases « the use of a waterproof covering is « recommended.

« Cement mortar casings can give « good results when the structures they « protect are sufficiently rigid. In « general coverings are preferred, made « of asphalt or consisting of several « layers of material or fibre, or better « still glass fibre impregnated with bi- « tumastic materials and even metal « sheets (generally copper) or sheets of « plastic materials.

« In view of the importance of the « casings for the proper conservation of « the bridges and the difficulties encoun- « tered in renewing them, it is necessary « to try and get casings which will last « as long as the bridges they protect. « In this connection, the recent intro- « duction of plastic materials has to date « given satisfactory results. It is to be « hoped that the use of thermo-plastic « materials will make it possible to ob- « tain this result, provided the casing « itself is suitably protected against « damage of a mechanical nature.

« For this purpose, the use of a pro- « tective coat, generally of concrete or « mastic asphalt is to be recommended.

« 15. If the masonry or concrete « bridge is threatened with deterioration « due to a lack of watertightness and « when operating reasons prevent the « carrying out of repairs to the casing, « waterproofing processes may be used « applied to the soffits or through them, « making it possible to reduce permea- « bility effectively or even doing away « with the drains altogether.

« 16. Heavier loads and higher speeds « can be allowed over old masonry « bridges than those provided for when « they were designed, provided a very « careful check is made of the condition « of the bridge; calculations for veri- « fying the strength are not generally « considered necessary.

« Carrying out work to strengthen « masonry bridges with the sole object « of allowing heavy loads over them is « consequently in practice unusual.

« 17. The work of repairing or « strenghtening the arches involves spe- « cial precautions to avoid abnormal « distribution of the stresses (anchoring « irons, seams, jagging, centering).

« Partial remaking of the arches is ad- « vantageous if it only affects a relatively « restricted portion of the bridge and if « the condition of the remainder of the « arch, abutments and foundations is « such that a long useful life can be « expected from the repaired bridge.

« 18. The organisation of the inspec- « tion and maintenance of bridges varies « according to local circumstances; it is « not possible to establish any general « rules concerning the most rational « maintenance methods for bridges.

« Where the roads are adequate so « that it is easy to get to the place of « work by road, it may not be advan- « tageous for the railway to do the work « itself, unless there is only a small « amount of work to be done.

« The geographical position and oper- « ating conditions on the railways may, « on the other hand, make it advanta- « geous to carry out work of greater « importance, or even oblige the rail- « way to do all its own maintenance « work without distinction.

« 19. Those Administrations who « themselves carry out maintenance « work of some importance have specialised gangs, generally used exclu- « sively on the maintenance of metal « bridges.

« 20. The materials needed for the « repairs carried out by the bridge gangs « are generally supplied from the stocks, « stores or depots of the Administra- « tions, whereas those needed for work « carried out by contractors are sup- « plied by the latter.

« Several Administrations, however, « prefer to supply in all cases the paint « needed to repaint metal bridges. »

QUESTION 2.

Very long rails. Welding methods. Transport of long welded rails and necessary equipment for transporting, laying, fixing, ballast, tamping, etc.

Economic aspect of the question. Present tendencies.

SUMMARIES.

« 1. The name of long welded rails « (L. W. R.) is given to rails the central « part of which never undergoes any « movement due to temperature altera- « tions. The minimum length fulfilling « this condition depends on conditions « of climate, ballast, and method of fix- « ing the rails. Normally, this minimum « length is of the order of 100 metres.

« 2. At the present time long welded « rails have undergone the test of nine « years service in various climates, on « lines with the heaviest and fastest « traffic, without causing undue diffi- « culty. They are the best solution « known today for obtaining at one and « the same time smooth running, good « preservation of the track and of the « rolling stock, and for reducing consi- « derably the maintenance costs.

« 3. From the theoretical point of « view, there are no limits to the length « of L. W. R., for this reason the deter- « mination of the actual continuous « length the most suitable in practice is « based on practical considerations. « These have not been judged in the « same way by the different Adminis- « trations.

« Certain Railways fix this length « simply in accordance with operating « requirements (track equipment, such « as insolated joints and switches and « crossings), whereas others consider « that it is not desirable to exceed a « length of 800 to 1 000 metres.

« The majority of Railways use long « welded rails in straight track and in « curves of which the radius is not less « than 500 to 800 metres, according to « the type of sleepers used. The mini- « mum radius varies in accordance with « climatic conditions and the materials « used in the track. In particularly fa- « vourable conditions certain Railways « come down to curves of a radius less « than 200 metres.

« 4. The use of devices for the initial « adjustment and the subsequent adjust- « ment or de-stressing of the rails de- « pends upon the practices of each « Administration. The Administrations « which use these devices consider it « necessary to de-stress rails in cases of

« difficulty. Other Administrations, on « the contrary, consider that normal « fishplating, together with a large number of anti-creep devices, give satisfaction.

« 5. All types of fastening which « assure firm and permanent connection « between the rail and the sleeper can « be used with L. W. R. As far as « elastic rail-spikes are concerned, experience of this type of fastening is « insufficient at the present time for a « final judgment to be passed.

« 6. Although the weight of concrete « sleepers makes them more suitable for « use in tracks laid with L. W. R. such « rails can equally well be laid with « complete safety on wooden or metal « sleepers. The number of sleepers per « kilometre is generally the same as in « tracks laid with fishplates, always « provided the number is at least 1 500.

« 7. The ballast should consist of « hard, sharp elements, of between 25 « and 60 mm in size.

« Wide and full ballast profiles must « be provided and maintained.

« 8. The method preferred where possible for making L. W. R. is to flash-butt weld in the shops the longest « lengths of rail that can be welded, « transport to their destination on suitable rakes, and join them together on « the site by the most suitable method. « For the latter, most widely used method is thermit welding. The majority « of Administrations agree that the two « welding processes cited above do not « need any subsequent heat treatment.

« 9. The final tightening of L. W. R. « should be made within a pre-determined temperature range, which according to the experience of most « Railways may be rather wide (up to « 25° centigrade).

« The mean of this range should equal « or exceed the mean annual temperature of the rail.

« If at the time of laying the track « the fastenings have been tightened « outside the desired range of temperature, it is recommended that destressing should be carried out, followed by a new tightening, when the « required conditions are fulfilled.

« 10. The maximum speeds allowed « on lines laid with L. W. R. are the « same as those allowed on lines laid « with standard length rails.

« Likewise the speed restrictions on « newly laid L. W. R. are similar to « those laid down for newly laid classic « type lines.

« 11. The most suitable methods of « maintenance have not yet been definitely determined, but the majority of « the Administrations adopt the same « methods for L. W. R. as they do for « rails of normal length. In general it « is agreed that no work involving « removal of the ballast, or lifting the « track, should be carried out, when the « temperature appreciably exceeds that « at which the track was laid in or most « recently adjusted. »

2nd SECTION. — Locomotives and rolling stock.

QUESTION 3.

Design and improvement of railcars and multiple-unit Diesel trains, as regards :

- **traction power equipment (location and suspension of the engine, type of transmission);**
- **characteristics of the construction (body and bogies);**
- **weight reduction;**
- **sound-proofing, heating, ventilation, air conditioning (supply of power required, advantages and drawbacks);**
- **buffer and traction gear. Intercommunication.**

SUMMARIES.

« 1. The number of types of different « designs of Diesel railcars should be « limited as far as practicable. The « economy of railcar operations im« proves with the number of completely « identical units in service in the area « of the Administration.

« 2. Whilst it may be necessary, for « reasons of traffic requirements, to « provide various types of interior arran« gements and equipment, all efforts « should be made to maintain unifor« mity of design, as relating to the most « important components subject to wear « and tear (as, for instance, traction « power equipment, auxiliary machinery, « running gear, brakes, buffing and draw « gear, as well as certain details, such « as doors, windows, etc.).

« 3. The installation of a single trac« tion power unit (Diesel engine plus its « transmission) in each motor unit is « the more economical method, if suit« able equipment with the necessary « power output is available on the « market.

« The installation of two separate « units, for reasons of operating relia« bility, is no longer necessary, in view « of the present high standard of design « and manufacturing technique.

« A subdivision of the total power « output in two separate units may be « opportune for the following reasons :

« (*a*) Limitation of types of mechan« ical equipment in use;

« (*b*) To permit the utilization of « engines and/or transmissions available « from mass production of the motor « vehicle industry, thus benefiting by the « relatively low first cost and main« tenance charges for spare parts.

« A division of the power unit in two « may also become inevitable, if power « requirements make the installation of « a single unit impracticable.

« 4. High speed Diesel engines are, as « a general rule, preferable for use in « Diesel railcars because their dimen« sions are smaller, they are easier to « mount and their weight is less.

« 5. Supercharging of Diesel engines « (provided the design is suitable), and « in particular of 4-stroke engines of « medium and relatively high rating, may

« be recommended for the reason that « a notable increase in power — up to « 50 % in the higher power ranges — « may be obtained at the cost of a relatively modest increase in load and « thermal strain.

« 6. Present experience shows that « preference is generally given to « 4-stroke engines which more easily « permit the advantages of supercharging to be applied.

« 7. In the design of a vehicle, particular importance should be attached « to accessibility of the power equipment.

« The underfloor arrangement of the « latter can be used for small to medium « ratings (up to about 500 HP with « high-speed engines) and provides the « advantage of more space for pay load « in the car body. Where it is desirable to have a particularly low level « floor, however, space may not be « available to permit such arrangement.

« The tractive power equipment of « medium to high rating may be installed « either in the bogie or in the car body.

« Installation in the bogie offers the « advantage of facilitating the exchange « of the entire power unit, inclusive of « its bogie, but accessibility is more « easily attained, even in operation, by « installation in the car body.

« The protection of the power unit « against bad weather conditions, and « dust as well as a more efficient noise « insulation are more easily realised « with the installation of the engine in « the car body.

« 8. The following transmission systems are in use :

« (*a*) mechanical, hydro-mechanical « or hydraulic transmissions for low « power ratings. The mechanical transmission has better efficiency. Its « drawback is that vehicle speed and « engine speed are related in a fixed « manner in each gear. Therefore, any « equipment having a mechanical gear « must have an efficient friction clutch « which will compensate for the speed « difference between engine shaft and « driving shaft during the starting period.

« In more recent times, mechanical « gear with hydraulic couplings ahead « of them have also been frequently used « for this purpose.

« (*b*) because of increasing construction difficulties with friction clutches « as power increases, mechanical gears « with hydraulic converters ahead of « them, or hydraulic transmission are « used for medium up to higher power « ratings. Towards the top of the medium range, electric transmissions are « in service.

« (*c*) hydraulic or electric transmissions exclusively for high power ratings. At the present time, both systems have been giving satisfactory « results in service even for higher output. They are practically equivalent « as regards their efficiency. The advantages of hydraulic transmission in « the starting period have to be compared with the advantages of electric « transmission as regards regulation, particularly in the part load range. The « question as to which system is to be « preferred depends, apart from the

« operating conditions, or the availability « from industry of suitable proved types « for the vehicle under design.

« 9. The position of the power unit « (Diesel engine with its transmission) in « the railcar is influenced by :

« (*a*) type and location of the Diesel « engine, and

« (*b*) choice of transmission system.

« Both the mechanical and hydraulic « transmissions require a more restricted « layout of engine, transmission, and « driving axles.

« The electric transmission on the « other hand, allows greater freedom in « the arrangement of the power unit « with its generator and the axle drives « (traction motors).

« 10. In order to ensure the proper « functioning of the power unit in oper« ation and to enable suitable measures « to be taken in the event of a break« down in service, the installation of « suitable supervisory instruments to be « watched by the driver or of automatic « control apparatus is to be recom« mended, covering for instance, the « engine coolant temperature, engine « coolant reserve, oil pressure and oil « temperature.

« Any automatic supervisory equip« ment should function on the « fail to « safety » principle in order to ensure « that in case of any failure the equip« ment under supervision will be swit« ched off. Indicator lamps locating « failures should be provided, not on « the driver's panel, but in the neigh« bourhood of the machinery to which « they refer.

« Automatic control has the advan« tage that it :

« (*a*) is continuous so that it becomes « immediately operative in case of « failure, and

« (*b*) leaves the driver free for the « performance of his other duties as they « relate to train operation, etc.

« Its drawback is a somewhat higher « expenditure for first cost and main« tenance.

« Traction power installations of high « rating, which are necessarily expensive, « warrant the installation of automatic « control apparatus.

« Alarm apparatus or indicators of a « more simple design should prove ade« quate for less costly power equipment « operating under less exacting condi« tions.

« In the case of automatic control, « the indicators provided on the driver's « panel should be kept to a minimum, « and so far as possible, should consist « only of those indicators required to « assist him in the operation of the train. « A single warning indicator may be « provided to cover failure of the power « equipment.

« 11. Water cooling of engine has « been of general practice up to the pre« sent. It is known that air cooling has « been used in a limited number of cases « in the lower power engines.

« Water-cooled Diesel engines make « protective measure of the cooling sys« tem advisable against :

« (*a*) corrosion and erosion;

« (*b*) scale formation and incrustation;

« (*c*) freezing during the cold season.

« 12. For hydraulic transmissions with « coupling characteristics and for mechanical transmissions, the inclusion « of a protective device for the engine « against overspeeding through torque « exerted by the driving axles is to be « recommended.

« 13. The driving position(s) of Diesel railcars and their control trailers, « if any, and of multiple-unit sets, respectively, should be arranged in such « a manner that :

« (*a*) a good visibility is ensured;

« (*b*) the travelling direction may be « reversed without turning the vehicle.

« These conditions are most satisfactorily fulfilled with the driving position(s) arranged at the end of the « vehicle.

« But the provision of a single driving position at a high enough level « either at one of the ends or at about « the centre of the railcar also ensures a « satisfactory visibility, even if a trailer « is running ahead of the motor unit, « provided the vehicles are not excessively long.

« Where two cabs are provided, high-level positions afford greater safety « to the driving staff, especially in such « cases where part of the power unit is « built into the car body immediately « in front of the driving position at the « level at which an impact with possible « obstacles on the track might occur.

« Care should be taken in the design « of the driving position to ensure that « the driver is protected from eye strain « due to the inclusion in his line of « vision of the track passing directly « beneath his eyes.

« The provision of a driving position « at each end of the set suffices for twin « or multiple-unit sets, the components « of which are never used separately.

« 14. In railcars used under simplified conditions, with a single power « unit and not required to run jointly « with a control trailer or other motor « units, direct mechanical control of the « power unit and its auxiliary is possible « and adequate. This type of control is « reliable and economical to purchase « and maintain, because of its simple « construction.

« On the other hand, railcars to be « used jointly with a control trailer or « other motor units should be equipped « with remote control, unless the cost of « the staff needed to attend two or more « power units represents a smaller money outlay than the building, operation « and maintenance of multiple control « equipment.

« In designing for a strictly limited « combination of power units e.g. a twin « unit, a relatively simple and inexpensive multiple control may be provided.

« When the traffic requirements involve the use of a larger number of « power units, operated together by a « single driver, a multiple control system « in conjunction with fully automatic « supervision of power units, as described in item 10, is necessary.

« 15. One of the determining factors « of economic operation of Diesel railcars is the structural weight, as it « influences :

« (*a*) the determination of required « power output;

« (*b*) the fuel consumption;

« (*c*) the extent of wear and tear (in « particular of the running gear compo- « nents and brakes), and consequently, « the extent of maintenance costs;

« (*d*) the purchase price.

« It is advisable to limit the weight « — without impairing the safety of pas- « sengers, reducing travelling comfort to « any noticeable extent or incurring lia- « bility of heavy maintenance and rene- « wal costs — to an economically toler- « able minimum value.

« Efforts to effect weight savings « should extend to all components of « the railcars and their trailers and con- « trol trailers.

« A reasonable additional charge in- « curred by increased expenditure for « design and materials as a consequence « of an intensified lightweight construc- « tion may be tolerated to a certain « extent, in view of the expected savings.

« Construction methods recommended « to effect weight savings are :

« (*a*) use of cellular or tubular me- « thods of construction;

« (*b*) light-weight construction in steel « with extensive welding;

« (*c*) combined steel and light alloy « construction;

« (*d*) application of light metals and « their alloys and plastics;

« (*e*) utilization of light-weight me- « chanical equipment and other fittings;

« (*f*) use of new types of suspension.

« 16. At the designing stage of Diesel « railcars, the following measures suit- « able to enhance travelling comfort « should receive careful attention :

« (*a*) *Insulation against noise and vi- « brations* involving, so far as the car « body is concerned :

« — prevention of drumming;

« — absorption of noise;

« — insulation against noise includ- « ing the avoidance of openings admit- « ting noise in the car body. When « openings are unavoidable, they should « be carefully sealed to prevent noise « from reaching passenger accommoda- « tion,

« and relating to the engine and its « auxiliaries :

« — insulation against noise and vi- « brations produced by the traction « power equipment.

« A certain increase of the weight of « the vehicle caused by insulation requi- « rements is justified.

« (*b*) *Heating.* — The following sys- « tems may be recommended for the « heating of railcars, trailers, and con- « trol trailers :

« — hot air heating;

« — hot water heating;

« — steam heating;

« — electric heating.

« Where a hot air or hot water heat- « ing system is used in the railcar itself, « it is advisable, for the sake of power « economy, to make use of the waste « heat of the engine coolant. The ad- « ditional insertion of a heat generator « in the heating circuit is to be recom- « mended, permitting pre-heating of the « engine coolant and passenger accom- « modation before going on duty; these « systems also allow keeping both the « engine and passenger accommodation

« warm, if there are operating interrup-
« tions of long duration; and when the
« vehicle is working at reduced power.

« Steam heating systems should be
« applied only if railcars are to be oper-
« ated jointly with standard passenger
« carriages equipped with steam heating.

« The additional expense of electric
« heating is supportable where Diesel-
« sets are required with a high standard
« of comfort.

« Heating systems which make direct
« use of the heat of waste gases, cannot
« be recommended for the disadvantages
« inherent in such systems.

« It is especially important that the
« heating system used provides for a
« satisfactory regulation of heat and is
« quickly responsive to regulator settings.

« (c) *Ventilation*. — The ventilation
« of railcars used under ordinary condi-
« tions should be effected by opening
« windows and the provision of static
« suction ventilators on the roof; for
« services with a higher standard of com-
« fort, the installation of electric fans
« may be envisaged.

« Hot air heating systems should be
« designed in combination with the ven-
« tilation of the car interior.

« It is self-evident that, except for
« countries with an unusually hot cli-
« mate and subject to dust conditions,
« and apart from vehicles offering a
« rather high standard of comfort, the
« provision of an air-conditioning plant
« is prohibitive on account of its high
« cost and additional weight. Where
« such an installation is included, it is
« recommended that it should have its
« energy supply provided by a separate
« generator, driven by an auxiliary
« Diesel engine.

« (d) *Gangways*. — If the kind of
« service provided supports the addi-
« tional expenditure, it is advisable to
« provide gangways for the passengers
« between the individual railcars in a set,
« designed as :

« — gangway floor plates, normally
« for the use of railway staff only;

« — gangways with bellows of va-
« rious designs as a protection for pas-
« sengers against weather conditions and
« for safety and other reasons where a
« certain degree of comfort applies to
« the vehicles.

« (e) *Running gear*. — The running
« gear should be designed to ensure an
« optimum of riding stability, even with
« an average state of maintenance of the
« permanent way.

« With the exception of the most
« simple designs, bogies should be used
« in the running gear.

« As an additional means to improve
« riding stability, one or more of the
« following devices should receive care-
« ful attention :

« — coil springs or torsion bars,
« practically self-damping, for the secon-
« dary and primary suspension, together
« with hydraulic shock-absorbers; special
« care must be taken to counterbalance
« the natural frequency of vibration of
« the various suspension systems;

« — self-damping springs of rubber
« or combined designs of steel and
« rubber;

« — guide bars between axle-boxes

« and bogie frames, instead of the ordinary axle-boxes sliding in the horn guides, to eliminate the play in the longitudinal and transverse axes and to avoid wear and tear;

« — locating the bogie pivot at the lowest practicable level.

« Air spring systems, as well as any other design of springs with a gas or vapour chamber, have thus so far seen little use in the design of railway vehicles, so that experience with this type of suspension is still lacking. However, it may be opportune to study the applicability of such systems, especially in view of the fact that the tendency is unmistakably in the direction of light-weight construction. With this type of construction the value of the inherent possibility of these systems to ensure an automatic adaptation of characteristics to widely fluctuating loading conditions is obvious. These new systems may show the way towards genuine improvements; several experimental vehicles are already in use.

« 17. *Buffer and traction gear.*

« If the possibility has to be envisaged that passenger coaches and goods wagons equipped with the ordinary buffing and draw gear may have to be hauled by railcars, the latter must be equipped similarly. In this event, it suffices, however, to employ a lighter design of such buffer and traction gear, as the loads to be hauled will be light.

« Where no such possibility has to be taken into consideration, automatic centre couplings may be used as standard equipment for railcars and their trailers. They are especially advantageous in services requiring quick coupling and uncoupling of units en route.

« The automatic centre coupling may be designed to ensure automatic coupling of the brake air line and multiple control circuits.

« 18. Fire protection is an important factor in passenger and rolling stock safety. The effectiveness of the measures taken for this purpose are implicit in the arrangements provided in the construction. »

QUESTION 4.

Comparative study of the periodical maintenance and repair of electric locomotives, in particular as regards :

- **the wear of the tyres (influence of the wheel diameter, the axle-load, the speed, the type of bogies and eventually undulatory wear of the rails, etc.);**
- **the maintenance of traction motors and their transmission (flash at the collectors and methods of coping with it, use of roller bearings for the suspension of the motors and the hollow shafts, etc.);**
- **lubricants used (classical and such new types as bisulphide or molybdenum);**
- **wear of the friction strips of the pantographs.**
- **Kind of work and periodicity.**
- **Organisation of the maintenance and influence of common user (banalisation) of the locomotives.**

— **Prime cost in relation to the type of equipment and the age of the engines.**

SUMMARIES.

Wear of rails and tyres.

« 1. The life of rails under electric « traction, according to some Adminis« trations, is less than with steam trac« tion. This is not only due to electri« fication itself, but in particular to the « more intensive services which nor« mally accompany electrification.

« Flange wear on tyres and side cut« ting of rails has been greatly reduced « by the provision of lubricators placed « at suitable positions at curves or on « the locomotives. The reduction of « flange wear is of great economic im« portance as approximately three times « the flange wear has to be removed « from the thread of the tyre to reform « the flange.

« 2. The amounts of wear permitted « for tyres vary somewhat between the « Administrations and are based mainly « on experience. Practical and theo« retical studies to determine better limit« ing profiles are being pursued.

« Some Administrations have so far « used only nose suspended motors; « others have also used fully suspended « motors. It has not been possible to « establish any definite relationship « between motor suspension systems and « wear on tyre or rail. Whereas fully « suspended motors have been adopted « principally for the advantages gained « in the working conditions of the mo« tors themselves, it is also anticipated « that the reduction in unsprung weight « will result in an improvement in the « life of tyres and rails.

« Practically all new electric loco« motives are being constructed in the « double bogie designs which limit wheel « diameter to a maximum of about 4 feet « (1.250 m). This does no doubt in« crease tyre wear and rail end ham« mering, although there are no quanti« tative effects to report but it is con« sidered that these drawbacks are « largely compensated by the advantage « of total adhesion of the locomotive.

« Tyre wear does not vary in any « relationship to its machined diameter « within the overall variation permitted « between maximum and minimum « thickness.

« 3. No general agreement is indi« cated to limitations of axle-loading to « wheel diameter. There are indications « that thought is being given to this and « some Administrations have in mind a « figure of 4.5 to 5 tons (axle load) per « foot of diameter (14.5 to 16.5 tons « per metre). Such figures may how« ever place onerous restrictions on loco« motive design.

« There is no direct evidence that the « increased average speed of electric « traction, by itself, contributes to rail « or tyre wear.

« There is no clear indication of the « effect which the type of bogie (arti« culated or non-articulated) has on « flange wear. Some Administrations « report reduced flange wear with bogies « having a centralising link between « them. Any increase in recoil force « beyond a certain limit, however, in« creases the amount of flange wear.

« Severe rail corrugation is only re-
« ported by one Administration.

Maintenance of traction motors.

« 4. Design of traction motors should
« enable as high a mileage as possible
« to be obtained before commutators
« are re-turned. Mileages of 500 000
« (800 000 km) should be obtained so
« that re-turning may not be necessary
« before the general repair stage of the
« locomotive is reached. There is a
« constant aim to make this mileage rise.

« The use of modern insulating ma-
« terials allows, on one hand, the design
« of new motors with a higher power in
« relation to volume and on the other
« hand, an increase in the life of exist-
« ing types of motors.

« There is division of opinion as to
« whether it is necessary to fit keys in
« armature shafts and pinions; the fitting
« of keys predominates on older types
« of motors but there is a tendency to
« eliminate keys in new types.

« It is universal practice to fit pinion
« on to shaft by shrinking on a taper.

« Opinion is also divided concerning
« the desirability of keeping pinions and
« spur wheels mated.

« 5. Flashovers on electric locomo-
« tives are rare. They are generally
« caused by frost and snow, contamina-
« tion by smoke, dust and exhaust from
« steam locomotives or by lightning.

« The preventative measures which
« are detailed in the reports, concern
« briefly :

« current collection,

« design of motors,

« design of protective equipment,

« design of control gear and driving
« technique.

Lubricants.

« 6. Grease lubrication is used gener-
« ally in traction motor armature roller
« bearings.

« Both grease and oil are used in axle
« or hollow shaft bearings.

« Different characteristics are speci-
« fied in lubricants to meet seasonal
« changes of temperature but generally
« this becomes a gradual change towards
« the desired properties by addition
« rather than complete changes.

« Heavy grease or gear compound is
« used universally in traction motor
« gear.

« No reports of the use of new lubri-
« cants (bisulphide of molybdenum or
« lithium) have been received.

Wear on the pantograph strips.

« 7. Pantograph strips most generally
« used are flat strips of copper, alumi-
« nium copper, cadmium copper or cop-
« per bearing steel but there is a ten-
« dency to a more general use of carbon.

« Recent experience and trials have
« shown a tendency towards more gene-
« ral use of carbon and metallized car-
« bon.

« Graphite grease is the most usual
« lubricant. It can be applied quickly
« and easily and is effective.

« When pantograph strips are worn, it
« is usual to change pans.

« For a given material, strip life varies
« considerably, being influenced by cli-

« matic and atmospheric conditions, « speed, type of service and pantograph « pressure.

« Upward static pressure of panto- « graph is generally specified to be « between 16 and 20 lb. (7 and 9 kg).

Organisation of maintenance and periodicity.

« 8. Electric locomotives are expected « to run large mileages of the order of « 500 000 miles (800 000 km) over a « period of 4 to 5 years before requiring « complete overhaul. Certain Admi- « nistrations report increased mileages « with new locomotives.

« Daily inspections are of a very « minor nature when they are carried « out; depot inspections vary widely be- « tween Administrations (from 7 to « 45 days according to the type of « inspection and service operated).

« Three principal components which « may govern periods between depot « inspections are pantographs, brake « blocks and tyres.

« A change of bogie, either in works « or depot, or the use of re-profiling « equipment without removal of the « wheels from under the locomotive al- « lows the rapid return of the locomotive « to service when the tyres require « reprofiling.

« A few Administrations replace « heavy flange wear of tyres by deposi- « tion of weld metal without subsequent « machining.

Organisation of the service.

« 9. Common user of electric loco- « motives, without segregation to indi- « vidual drivers or small groups of « drivers, is practically universal, parti- « cularly on the longest services.

« Unless there are particular local « reasons, there is no need for loco- « motives to return to depot until re- « quired for periodic maintenance. They « can be immobilised in sidings and sta- « tions or on stabled trains ready to « start work.

« Electric locomotives are capable of « practically continuous working and « all Administrations aim at keeping « them on continuous duty, changing « crews whenever necessary.

« Adequate cab heating is necessary « when locomotives work or are tem- « porarily stabled in low atmospheric « temperatures.

Cost of maintenance.

« 10. Only one Administration quotes « a relation between maintenance and « age of the locomotives. A more « general point of view is that it is more « closely related to the age of design.

« 11. The ultimate basis upon which « maintenance costs can be judged is « cost per mile or kilometre.

« The general aim is to obtain a very « high mileage before workshop heavy « repairs with extensive dismantling are « necessary and at the same time to keep « day to day maintenance costs low. « The items which may contribute to « this aim are :

« — critical examination of costs of « repairing components;

« — critical examination of frequency « of repairs to components;

« — improvement of design to reduce « wear and frequency of repairs;

« — improved design to facilitate « accessibility and the removal of com« ponents in unit assemblies for repair « off the locomotive;

« — improvement of workshop me« thods to reduce cost of repairs;

« — specialisation of the manufac« ture of spare parts and components;

« — training of staff for specific « maintenance operations.

« Although the cost of each short or « long period inspection is low, the sum « total of depot maintenance is high — « in some cases greater than Main « Works maintenance and this gives « considerable scope for scrutiny with « a view to effecting reduced costs.

« The overall requirement, for which « the electric locomotive has the possi« bility with suitable design and manu« facture, is extensive user with mini« mum of idle periods, together with « long periods between withdrawals for « maintenance purposes. »

3rd SECTION. — Working.

QUESTION 5.

a) Handling facilities in the goods depots for consignments in less than carloads, containers. General arrangement of the depots. Liaisons between the staff of the depot and the delivery services.

b) Railway problems regarding the introduction of general palletisation of packages.

SUMMARIES.

I. General observations.

« 1. The relative importance of the « parcels traffic differs appreciably from « one country to another. It is linked « up with the economic and social struc« ture of each country and also, natu« rally, with the general organisation of « its transport.

« Each Administration must not over« look such parallelism, as the evolution « of these structures affects the parcels « traffic and requires decisions to be « reached concerning the organisation « and measures of adaptation to be « taken.

« 2. The permanent objective to be « aimed at is to improve the parcels « traffic both as regards quality (rapidity « and regularity of transport, no da« mage, door-to-door transport) and « costs.

« In this connection it is essential :

« — to reduce handling operations;

« — to mechanise such handling;

« — to make good use of the wagons.

« 3. The « classic » type of organisa« tion into regions and regional centres, « based on the advantages gained by the « concentration of the parcels (by road « and by rail) at a reduced number of « transit points and the making up of

« long distance through-wagons is adopted by all the Administrations of some « importance.

« It limits the number of stages and « makes it possible, if the regional centres coincide with localities having an « important traffic of their own, to « transport a large number of parcels « directly without transhipment.

4. In order to have regular through « services, it is advantageous to run « them two or three times a week or to « operate them with road vehicles.

« However, in particular, it is impossible for very extensive railway systems — unless they consent to an « inexcusable waste of rolling stock — « to operate regular through services « between all their regional centres. « Intermediate transhipments are unavoidable for a certain number of « long-distance consignments. It is advantageous to concentrate them into a « small number of selected and suitably « equipped points.

« It is of advantage if such points « coincide with the regional centres.

« 5. Within the framework of the « classic organisation, a free hand can « to some extent be given to the stations « to run other wagons than regular ones. « The conditions under which such « wagons are put in operation must be « linked up with the length of the runs « they have to make; the longer the run « the more necessary it is to get sufficient use of such wagons.

« This method, which can be used by « all the consigning stations, makes it « possible to avoid transhipments (transhipment at the centre station of the « departure region or even at the centre « station of the arrival region).

« Certain Administrations use this « method in the transhipment stations « as well, but the rational use of such « wagons then presupposes a preliminary knowledge of the actual traffic :

« — either by a preliminary storing « of the parcels on the platforms, which « involves additional handling;

« — or by preparing the work of the « depots concerned from the waybills « when these are sent with the wagons « or by a parcels traffic planning.

« 6. Certain Administrations use the « transport documents to regulate the « forwarding of the parcels. Carried « out in somewhat various ways, such an « organisation makes it easier to :

« — determine the cause and responsibility in case of delay, loss or « damage;

« — organise and control the handling operations.

« In other countries, the transport documents are forwarded separately and « are only checked against the parcels « on arrival. Such an arrangement simplifies and appreciably speeds up the « loading and unloading of the wagons « at departure or en route.

« 7. In many countries, the checking « at departure and arrival has been considerably simplified in order to speed « up the work and reduce costs.

II. Goods depots.

« 8. In depots where no transhipments take place, it is recommended « that there should be areas for the

« handling of incoming and outgoing « goods under one roof.

« This arrangement makes it possible « to reduce the staff required for « handling, and facilitates the supply of « empty stock (wagons and pallets) to « the « outgoing » area.

« It may make it possible to deal with « seasonal variations in the traffic by « extending one area at the expense of « the other, or even exceptionally, pro- « vided door to door deliveries are car- « ried out immediately by the delivery « service, to use the same area for both « purposes : handling at arrival in the « morning and forwarding in the evening.

« In the interest of the customers, it « is desirable to avoid forwarding in « separate buildings allocated to dif- « ferent destinations.

« 9. In stations with a transhipment « area, especially in the regional centres, « it is advantageous, in order to obtain « a greater concentration of parcels, to « juxtapose :

« — the « transhipment » and « ar- « rival » or « transhipment » and « de- « parture » areas, according to the « amount of traffic that can be com- « bined in this way;

« — or even, better still, to combine « all the areas into a « single depot ».

« 10. Railway depots must be, as far « as possible :

« close to the industrial and com- « mercial areas of the towns they serve;

« have convenient road access and a « long road frontage which can be « extended should the road services « eventually be further developed;

« and have easy connection by rail « with the reception and formation sid- « ings for the parcels trains; for this « purpose the marshalling yard should « be as close as possible to the depots.

« 11. Most of the depots with small « or average traffic are so designed that « they have an extensive length and can « be served by a single siding, or two « at the most.

« Large depots, especially those which « include a transhipment area must, on « the other hand, be planned on com- « pact lines so as to reduce the distance « goods have to be conveyed over; they « are therefore always served by several « sidings.

« Arrangements which include dead- « end sidings and a platform at right « angles to them avoid the operations « of conveying the goods and bringing in « or taking away wagons interfering with « each other.

« 12. When it is necessary to cross « over the sidings to get from one plat- « form to another (as in the case of very « long platforms or depots served from « both ends), the goods can be handled « by going through the wagons or else, « use can be made of flat wagons ar- « ranged for this purpose, or finally in « the case of large installations, fixed « bridges with a moveable deck can be « used.

« 13. The design, space required and « division of the handling areas depend « mainly upon the following factors :

« — the amount of goods to be « handled and the relative volume of the « peak traffic;

« — the ratio in amounts of incom- « ing, outgoing and transhipment goods;

« — the number of destinations over « which the traffic is spread and the « number of delivery zones;

« — the existence of collection and « delivery services belonging to or at- « tached to the railway;

« — the system of dispatch;

« — the method of working adopted « with or without mechanisation of « handling operations.

« 14. The most generally prevailing « tendency as regards the layout of the « different areas in the large depots can « be summed up as follows :

« — « consigning » areas limited to « the space necessary for accepting, and « if necessary, sorting parcels before « conveying them to the wagons;

« — extensive « arrivals » areas be- « cause of the space needed for the « storage of the parcels pending delivery.

« It should be noted that :

« — when goods are collected at the « station much more room is needed « than when they are home-delivered;

« — the space required for the stor- « age of parcels at the end of the week, « which parcels cannot be delivered be- « cause the shops are closed is generally « becoming greater and greater owing to « the social evolution taking place.

« As regards the platforms serving the « sidings, their width varies dependent « on the mechanisation of the handling « and the amount of goods to be put « onto the platforms before being loaded « into the wagons.

« 15. The development of mechan- « ised handling makes it necessary to « see that there are no obstacles on the « platforms and that these have good « running surfaces.

« In nearly every country the height « of the platforms corresponds with that « of the floors of railway vehicles « (1.15 m to 1.2 m = 3′ 9 3/8″ to « 3′ 11 1/4″), so that goods are handled « on the same level.

« There are difficulties on the road « side in every case, since the floors of « private lorries and delivery vehicles « are at very varying levels.

« In order to handle heavy parcels, « pallets and small containers, in spite « of such differences in level, certain « Administrations use fixed bridges or « moveable ones operated by jacks.

« In this connection some standar- « disation of the different categories of « road vehicles would be advisable.

III. **Traditional handling.**

« 16. The wheelbarrows, stillages and « hand trucks commonly used in the « small stations are also adequate equip- « ment in the large depots for all han- « dling of goods of low weight or small « size within a limited radius of action.

« 17. In the large depots, when the « goods have to be conveyed over longer « distances, it is essential, in order to « reduce costs, to group the parcels into « larger units for internal transport and « to mechanise their conveyance.

« This is effected by loading them « onto power trucks, or on trailers or « semi-trailers which are then coupled « to tractors. Some countries also make « use of overhead or underground trac-

« tion-chains to which trucks are « coupled. Belt conveyors are rarely « used to move the parcels in this way.

« 18. Assembling quantities of par- « cels for grouped handling generally « implies their preliminary sorting per « destination.

« In the large depots, where the par- « cels are grouped for many different « directions, it is generally necessary to « set up several special sorting areas, « which involves additional handling.

« These operations can also be carried « out by making a preliminary simpli- « fied sorting of the parcels and by « using « distributing trucks », which « are in fact mobile platforms running « alongside the wagons to be loaded in « the yards (depots without platforms).

« 19. The sorting of parcels can be « facilitated :

« — in the area in which the wagons « are unloaded, by using slat-conveyors « or unloading machines;

« — in the area where small parcels « are sorted, by using conveyor belts.

« 20. With a few rare exceptions, the « special handling equipment is used in « particular where heavy parcels are « concerned.

« In the large depots the movable « hoists formerly used for this purpose « are being replaced to an increasing « extent either by fork lift trucks, or, in « the case of very heavy parcels which « are not loaded outside the shed by 1 t « to 3 t mobile cranes working inside the « shed, or large-capacity fork lift trucks.

IV. **Handling by means of pallets.**

« 21. When used for moving parcels « in the depots the pallet has the follow- « ing advantages :

« the handling of heavy parcels which « is difficult with truck on account of « their inevitable loading height is faci- « litated;

« the pallet provides a means of stor- « age for the parcels either by stacking « the pallets or by placing them on « racks; the use of pallets is therefore « extremely advantageous in depots « where space is scarce.

« 22. To be economic, handling and « conveyance should be carried out :

« over short distances, by hand pallet « trucks on simple rollers or, better still, « of the bogie type, or by pedestrian- « controlled power fork lift trucks;

« in the case of moderate distances « (50 to 150 m = 55 to 165 yds.) by « rider-controlled fork-lift trucks;

« for longer distances, by trains con- « sisting of lift trucks and trolleys. The « fork lift trucks can then be used as « tractors if they are powerful and fast « enough. Traction chains can also be « used for this, hauling either trolleys « loaded with pallets or hand operated « fork lift trucks which are loaded.

« 23. The fork lift trucks have in- « ternal combustion engines or electric « motors.

« The purchase price of the former « is lower, but the operational costs are « higher. In general, they are faster so « that they are likely to be preferred in « depots of extensive length; the Admi- « nistrations using them do not report

« any serious trouble arising from ex-
« haust gases.

« The characteristics of the fork lift
« trucks depend on the dimensions of
« the pallets used and those of the
« vehicles to be served (width of the wa-
» gons, width and height of the door-
« ways, etc.).

« The load which they can handle is
« limited by the strength of the wagon
« floors; it seems to be correct that a
« load of 1 t is sufficient for most Rail-
« way Administrations.

« Mention should be made of the use
« of devices with mobile forks or mobile
« lift-frames (adjustable or retractable)
« intended to facilitate the manoeuvres
« of the empty or loaded equipment.

« 24. Many Administrations would
« like to be able to buy for their small
« depots, simpler and cheaper hand
« pallet trucks and stackers, in principle,
« purely mechanically operated.

« Improvements to fork lift trucks
« from the point of view of their dead
« weight and manoeuvrability (radius of
« gyration, size) are also desired.

« 25. If the characteristics of the
« existing wagons are, in general, suffi-
« cient for the evolutions of fork lift
« trucks, a few improvements, as recently
« decided upon by the Member Admi-
« nistrations of the I. R. U. (U. I. C.),
« might nevertheless be considered in the
« design of future wagons such as :

« increasing the strength of the floor;

« increasing the width and, if possible,
« the height of the doorways.

« In this connection, interesting trials
« have been reported as regards wagons
« with sliding sides.

V. Collection and delivery services.

« 26. Many Administrations are in-
« terested in collecting and still more in
« delivering parcels.

« Sometimes these operations are in-
« cluded in the official rates for trans-
« port by rail and delivery is often as-
« sured either directly or through the
« intermediary of affiliated companies;
« if not, the Administrations conclude
« contracts with private firms in which
« they reserve the right of control of
« their services (service-times, charges).

« 27. It is necessary to synchronise
« the collection and delivery operations
« and railway timetables. This is parti-
« cularly important as regards collecting
« parcels and the departure of the par-
« cels trains.

« As far as arrivals are concerned, the
« consequences of possible delays on the
« railway are mitigated by the fact that
« there are often two delivery rounds a
« day in the large centres.

« 28. The conditions under which
« goods are transferred to the haulage
« services are linked up with the delivery
« methods used.

« Most often the parcels are loaded
« onto the delivery vehicles in the op-
« posite order to that of the delivery
« round.

« In general, the delivery man being
« the one who best knows the round
« executes the loading :

« — either — usually — by collect-
« ing parcels already sorted by the rail-
« way staff and put into the bays allo-
« cated to the different areas of the
« town;

« — or by calling out the parcels which they have on their documents which are then conveyed by the depot staff from the place where they have been stored to the delivery vehicle.

« Exceptionally, the parcels are loaded into the haulier's vehicle immediately (which implies the use of sparsely loaded trucks); in this case the depot staff can load the parcels as soon as they come in directly on these trucks, thus reducing handling and the area of covered platform required for arrivals.

« On the departure side, the hauliers are rarely required to classify the parcels. This is only done in stations with multiple forwarding areas for different destinations, or when there is only a very limited time to dispatch the parcels in a given direction.

« One special case is that of the depots without platforms of certain Administrations; when the road vehicles can come in already sorted, the loads can be taken directly to the wagons.

« 29. From the technical point of view the haulage vehicles should be able to pick up and distribute heavy parcels, small containers and pallets.

« From the point of view of handling operations at client's premises where no platforms are available, the solutions tried : small cranes mounted on the lorries, elevating tail boards, low-loading trailers, etc., are encouraging but not always completely satisfactory.

VI. **Palletization.**

« 30. Apart from its use as a method of conveying the parcels within the depots, the pallet can be used to carry goods either during their transport in the wagons (internal palletization on the railway), or throughout the whole transport chain from the premises of the consignor to those of the consignee (general palletization).

« General palletization is recognised as the most advantageous; however, as it necessitates the co-operation of the clientele, it is as yet, practised on a large scale in only a few countries.

« More numerous are the countries which, whilst pursuing this objective, practise or develop internal palletization on their railway.

« The great majority of Administrations have undertaken studies or trials of palletization.

« 31. Those Administrations who have some experience of internal palletization on the railway, or of general palletization, stress the advantages of the pallet for the transport of heavy parcels or grouped consignments; they are of an opinion that palletization has made it possible provided that the staff is suitably trained to obtain :

« — a very marked improvement in the quality of transport (speeding up the dispatch, reducing damage and loss);

« — saving in labour;

« — less fatigue for the staff and fewer accidents during handling.

« In addition, general palletization enables clients :

« — to make savings in handling during the consigning and delivery of goods;

« — to facilitate and render the storing of goods more economical;

« — to use lighter packing when box-« pallets or stacking pallets are used.

« 32. Palletization must be debited « with :

« — the additional cost due to the « purchase of the pallets and the equip-« ment used to handle them, as well as « the corresponding maintenance costs;

« — the cost of labour for stowing « the parcels on the pallets and in the « box-pallets, which stowing has to be « done with great care;

« — the increase in the dead weight « to be carried by rail and road;

« — transport of empties.

« 33. The influence of palletization « on the average load of wagons is con-« troversial; many countries still have « insufficient experience and the esti-« mates which could be made also de-« pend upon the average load of the « wagons before palletization. Certain « countries have found that there is a « reduction in the average load but con-« sider that this does not lead to any « major disadvantage provided the runs « are not too long.

« It is essential to stack the pallets « in order to get good use of the capa-« city of the stock.

« On the other hand, the use of the « pallet may favour a good use of the « wagons by making it possible to tran-« ship as well as store economically :

« — the reduction in the cost of tran-« shipment operations may make it pos-« sible to give up certain traffic by direct « wagons of small or average tonnage;

« — the easy storing on departure « may make it possible to run through-« wagons for the long distance services « with little traffic at longer intervals « (every other day on three times a « week) with full loads.

« 34. The proportion of traffic that is « palletizable is high; countries where « internal palletization on the railway is « the current practice estimate that it « can cover 70 % or even more of the « traffic.

« However, the number of small par-« cels, light parcels and unpacked par-« cels as well as well as their hetero-« geneity from the point of view of types « of packings used gives rise to problems « which are being solved :

« — either by fastening the loads « placed on ordinary pallets (very care-« ful arrangement of the parcels in brick-« work fashion, hooping, sticking, adhe-« sive tape, etc.);

« — or by using box-pallets.

« However, box-pallets are costly and « the economic results of palletization « are the better, the more simple pallets « can be used, which would be facilitated « by a rational standardisation of pack-« ings.

« 35. From the point of view of car-« rying out the railway transport, there « should only be a few types of pallets, « which should all have unified basic « dimensions.

« These basic dimensions result from « the interior dimensions of the wagons.

« The pallets must be firmly cons-« tructed to be able to withstand the « numerous handling and transport oper-« ations they will have to undergo.

« Box-pallets are generally made of

« metal and have embedded ridges on « top to allow them being stacked. « Some are collapsible, but these are « more fragile and expensive.

« There are three types of open box- « pallets :

« rigid box-pallets with V shaped « opening;

« — rigid box-pallets with collapsible « sides;

« — box-pallets with removable sides.

« Closed box-pallets are replacing « with advantage the small containers « both in inland and international servi- « ces (transport of bonded goods).

« 36. Palletization has been favour- « ably received by the staff; in particular « the staff responsible for loading the « pallets has clearly understood that the « delicate job entrusted to them relieves « the physical efforts of the staff respon- « sible for handling operations.

« 37. It is difficult to draw up any « balance sheet for palletization, but on « the whole those Administrations with « sufficient experience of this technique « consider that it is economically justi- « fied as far as the railways are con- « cerned.

« In addition, palletization is a means « of considerably reducing handling at « a time when in many countries there « is difficulty in recruiting staff for work « of this kind.

« The above Administrations are also « persuaded of the value of palletization « in the field of the general economy « and of the development of this tech- « nique in commerce and industry. It is « important therefore that the railway, « being already in a position to profit « from this development by reason of « the favourable characteristics of its « stock, should strengthen this favour- « able initial position as regards compe- « tition by taking all possible suitable « commercial steps.

« 38. In order to assist consignors « who are palletizing their consignments « and taking into account the benefits « the Administrations draw from this, « the latter have introduced a certain « number of tariff measures :

« — the tare of the pallets is not « taken into account in determining the « weight of the load to be charged, a « weight limit being laid down;

« — attractive rates for client's pallets « returned empty;

« — railway pallets are supplied free « of charge or at a small hire charge.

« Some of these advantages are scaled « down in such a way as to favour « clients using pallets of a type similar « to those adopted by the Railway Ad- « ministrations themselves.

« Moreover upper and lower weight- « limits have been laid down, on the « one hand to take into account the « power of the handling equipment and « on the other, to obtain a sufficient « load.

« 39. In order to reduce the systema- « tic empty returns of client's pallets all « Administrations have set up or are « considering setting up pallet pools.

« This makes it essential for those « concerned to use pallets absolutely « identical with those belonging to the « railway.

« The periods within which the compensation of supply and return must « be effected are laid down by agreement. Certain Administrations accept « the principle of immediate compensation which, whilst being favourable for « clients, also has certain advantages for « the railway at times.

« 40. In view of the development of « international traffic, the general opinion of Administrations is that the « exchange of palletized loads transported under this regime should be « facilitated and even that pools should « be set up, in order to reduce the traffic « of empty pallets.

« This measure would also make it « possible to extend the sphere of action « and value of the national pools already « set up and to facilitate frontier crossings (handling ans customs operations). « International pools, however, like « pools with clients, imply standardisation of the types and dimensions of « pallets used; agreements in this connection are in the course of preparation. »

QUESTION 6.

When changing over to electric and Diesel traction for passenger train services, research of the principles which may lead to a rational and efficient organisation of same.

For this purpose to :

- **work on the social and economic needs and with this object in view, classify the passenger services according to the needs of the populations served, the distances, the volume of passenger traffic and its variations;**
- **fix, for each category, the traffic hours and advisable frequencies as well as the reasonable requirements of the public for comfort and speed;**
- **define the most suitable methods to draw up the timetables (including eventually regular interval train services) : choice of the type of train and rolling stock, fixing the runs.**

SUMMARIES.

« 1. A passenger service by rail is a « great advantage for the population of « every country and an absolute necessity for many. The habit of travelling « is increasing. The services must be « adapted to the development of the « public demand, whilst being kept « within the reasonable standards of « sound management.

« In case where the development of « the habit of travel is not translated « into an increase in the traffic by rail, « it is, possibly, the time to restore the « situation by other methods, particularly by a forward policy in fares, « before an increase in the service.

« 2. The principles on which a rational and efficient passenger service « is based can be summed up in the « words : convenience, reliability, speed, « comfort, and cheapness. Within the « framework of these principles, the « change to electric and Diesel traction « is a favourable opportunity of re-organising the services for the benefit of « both the travelling public and the « railway.

« 3. The capacity to work practically « uninterruptedly, the relative rareness « of breakdowns in service, the great « accuracy in running, the high capacity « for acceleration and sustained speed, « the ease with which multiple unit rakes « can be made up, and their great cleanliness, higher thermic output, greater « elasticity in the use of locomotives are « the main advantages of the methods « of Diesel and electric traction which « allow of the greater application of the « first principles above than is the case « with steam traction.

« 4. As a journey is to a large extent « a loss of time, one of the main objects « of a train service is to minimise this « loss, primarily by a judicious selection « of the departure and arrival times, « and by increasing the number of « trains and the average speed.

« 5. The selection of the departure « and arrival times of the trains must « give priority to the following two « objectives :

« — reduce the impact of the journey on ordinary working hours, and « consequently encourage night-time, « evening or half-day travel;

« — avoid train arrivals and departures between midnight and 6 a.m.

« 6. Consequently in the case of journeys lasting more than six hours, considering in turn those routes over « which the traffic justifies one, two, « three, four... services a day, the practice followed by the railways shows « that it is desirable for the timetables « to include in the order given the following trains :

« — a night train leaving between « 7 p.m. and midnight;

« — a day train leaving early in the « morning (in the case of journeys taking less than sixteen hours);

« — an afternoon train (in the case « of journeys taking less than twelve « hours);

« — one special high speed train at « the time most convenient for those « using it;

« — other trains at hours dictated « more particularly by the special characteristics of the traffic on the line.

« 7. If the journey takes less than six « hours :

« — the night train will be replaced « by an evening train;

« — the day trains will leave at hours « so chosen that the whole journey can « be made in half a working day or less, « including a meal.

« 8. The choice between a train service organised in groups and continuous services spaced out over the « day depends upon many factors, in « particular the length of the journey « and the number of travellers; as the « length of the journey decreases and « the number of passengers increases, « usually the Group services give way to « Continuous services and in the end to « Interval services in extreme cases. « This evolution is facilited by changeover in traction, and by the improvement of the railway equipment, particularly by the installation of new « track, by the installation of the most « modern techniques, such as centralisation of the control of points and the « amalgamation of signal boxes.

« 9. The Group services are suitable « for night services and for trains making important connections (with boat « services in particular).

« 10. An Interval service loses many « of its advantages for the passenger if « the time between two succesive trains « is more than 2 hours.

« 11. The structure of intermediate « stops depends on the needs of the « clientele between :

« — the two terminal stations of the « run;

« — the intermediate stations and the « terminal stations;

« — the intermediate stations themselves;

« with due regard to the connections to « be made.

« 12. If there is sufficient traffic, it « is right to carry the greatest possible « number of passengers between the « terminals by non-stop trains.

« If there is not sufficient traffic to « justify such trains, the need to provide « a reasonable number of trains is the « prevailing factor and intermediate « stops will ensure that sufficient « numbers use the trains.

« The changeover to electric and « Diesel traction, by reducing loss of « time due to stops, makes additional « stops that one would have hesitated « to make with steam traction more « acceptable.

« 13. As stops during the night disturb the passengers, the number of « stops made by night trains should be « reduced to the minimum.

« 14. Reliability and punctuality is « of the greatest importance. The timetables should not promise more than « can be reliably performed.

« 15. Reduction in the journey time « is an important factor in increasing « and maintaining traffic, especially over « long distances, and in the case of « services by day.

« The changeover in methods of traction produces undoubted advantages « in this connection, even if the maximum speed allowed over the lines in « question is not increased.

« Such and increase in the maximum « speed should only be made after an « economic study has been made to « ascertain the costs it will involve and « the advantage expected therefrom.

« Several Administrations report that « the great increases in the average « speed obtained in this way have been « in general profitable.

« 16. The use of passenger trains for « other traffics, in particular to speed « up some of the goods traffic, is only « acceptable to the extent that it does « not interfere with punctuality and the « structure of the passenger timetables.

« 17. Service stops must be cut down « as much as possible, in particular :

« — on international services by « making it the general practice to « carry out customs and police checks « during the run;

« — on services over lines with different systems of electrification, by « using locomotives capable of running « on different frequencies and voltages.

« 18. The efforts of the railways to

« improve the standard of comfort « offered as a rule should be directed « to the following points :

« — riding qualities;

« — heating;

« — sound insulation;

« — forced ventilation and air conditioning;

« — lighting;

« — design and arrangement of the seats;

« — interior arrangement of coaches;

« — extension of sleeper accommodation on night trains;

« — restaurant services (restaurant « cars, buffet-cars and trolley services);

« — general standard of cleaning « with particular development of cleaning en route on long runs.

« 19. In drawing up the passenger « timetables it is important to study the « best user of the rolling stock and of « the train crews; good user will make « operation more economic, making it « possible to deal with a larger amount « of traffic with a given amount of « stock (coaches and traction) and train « crews.

« 20. Tourist traffic in general and « social tourism in particular is growing « to such an extent that the railways « have to cope with considerable seasonal peak traffic. The transport of « these large numbers of passengers can « only be carried out under reasonable « conditions of comfort for the passengers and prime cost for the railway when the traffic is spread out. « Although some Administrations have « been able to obtain certain results (in « particular thanks to reduced fares and « special trains outside peak hours), the « object in view can only be fully attained with the collaboration of private « organisations and above all the intervention of the public authorities. An « active advertising campaign is an integral part of these efforts.

« 21. The daily suburban traffic « peaks of the great cities put the railways in the same difficulty.

« The changeover from steam traction to electric traction allows the railway to meet further increases in « traffic.

« Parallel with the study and application of all new techniques a « spreading out of the peak traffic, again « requiring the intervention of the Public « Authorities, can then avoid the need « for further heavy and unprofitable « capital investment. »

4th SECTION. — General.

QUESTION 7.

Advantage of the use of high speed electronic apparatus for certain administrative work such as :

1) the making out of pay slips;

2) traffic and stores accounts;

3) the checking of the movement of empty and loaded freight wagons, thereby improving the distribution of rolling stock;

4) compiling more rapidly already existing statistics, thus having also the possibility of preparing new ones.

SUMMARIES.

« 1. Electronic data processing machines (E. D. P. M.) are recent machines, the scope of which has been realised by the railways. An increasing number of Administrations of varying importance already use E. D. P. M. or are carrying out preliminary studies and are placing orders. However, at the present time the experience so far gained is not sufficient to make it possible to come to final conclusions.

« 2. Electronic data processing machines consist of units which, owing to the use of electronics operate at very high speeds and have a very high capacity; they are able to carry out any calculation or logical operation (comparison) working from a stored programme. The possibility of connecting, in varying number, units carrying out various functions (internal and external stores, input and output organs) give these machines great flexibility and makes it possible to adapt them to a progressive increase in the work.

« They are « machines for the automatic processing of information », and their potentialities are far in excess of those offered by standard punch card equipment. In particular, they permit the application of the so-called management by « exception » or « difference » method to problems comprising a considerable number of data or parameters, so that the machines are well suited to serve as instruments of management and, in particular, as a means of arriving at decisions.

« 3. Electronic data processing machines thus appear to be suitable for dealing with all the problems arising from the management of a railway system, in particular :

« — control of staff and of supplies and materials;

« — accountancy;

« — costing;

« — budgetary control;

« — user of rolling stock (turn-round);

« — statistics;

« — studies of fares and charges;

« — technical and scientific calculations (time table calculations, etc.).

« 4. The applications first dealt with by an electronic data processing machine are, in most cases, those already handled by standard punch card methods. The study of these applications is easier, and economic advantages can be derived from the equipment more rapidly. In addition, the staff can gradually become familiar with the possibilities of the E. D. P. M. and is in a position to carry out more efficiently the study of complex problems.

« 5. The most complete utilisation of the potentialities of electronic data processing machines consists in « centralized management » or « integrated data processing », i.e. the centralized processing of all data contained in the various basic documents in which the activity of the system is reflected, with a view to obtaining from them all the results required for management purposes in all spheres. The electronic

« data processing machine thus represents a « Management Information Centre », at the disposal of the different departments.

« Several E. D. P. M. of lower capacity decentralized and adapted to specific functions would be capable of dealing with different problems, having regard to the time within which the various data ought to be processed. In this case, liaisons at managerial level are necessary to exchange and exploit the partially processed results.

« It is important to make the point that such a conception is by no means incompatible with the decentralisation of executive functions which is indispensable in a railway system. Introduction must be gradual and calls, in particular, for a very detailed study of all the information circuits of the system and for a very efficient organisation of the internal links within the Administration.

« 6. The use of an E. D. P. M. appears primarily to require a minimum level of activity measured in terms of basic data. The appearance on the market of E. D. P. M. of low capacity tends to reduce the minimum level.

« 7. Also the achievement of the following conditions facilitate the practical use of an E. D. P. M.;

« — the creation of a suitable system of links between the establishments from which the basic data emanate, the E. D. P. M., processing this data and the departments interested in the results;

« — the translation into machine language of the basic data at a point as close as possible to their source.

« 8. Electronic data processing machines appear to be suitable for the handling of problems common to several Railway Administrations : common tariffs, exchange of materials, wagon pools, etc.

« 9. As regards the economic aspects it is necessary to take into account :

« — direct savings compared with the present management methods;

« — the indirect advantages resulting from improved efficiency of management owing to the supply of more exact and more up to date information and also as a result of the possibility of solving certain problems by operational research.

« 10. Of necessity the preliminary studies preceding the installations of an electronic data processing machine take a long time and are very complex. They call for an efficient organisation and for specially trained personnel. The best way of dealing with this type of studies appears, to be the setting up of « Working Teams », consisting of permanent representatives of all the departments concerned with a particular application.

« 11. It is suggested that the question should again be put on the agenda of a future Congress at a time when the Administrations will have acquired sufficient practical experience in this field. »

QUESTION 8.

Financing and conserving railway properties and assets.

Study and comparison for limited companies, partially state-owned companies and State Railways, of the financial means used for the normal renewal of installations and rolling stock.

Forms of amortization and renewal, taking into account for the latter, the slow or speedy depreciation of the currency.

SUMMARIES.

« 1. The great majority of the Administrations replied in the negative to « the question if the state of their equipment corresponded to the present state « of the technique, and to the present « needs of the traffic. Very great arrears are in general ascertained in the « renewal and modernisation of both « fixed installations and rolling stock.

« 2. In certain cases these arrears can « be explained by war damage and the « post-war disturbances. The main « reason, however, lies in the fact that « the traffic receipts of the railways are « insufficient to finance by their own « means the renewal and modernisation « of their equipment, as industry generally has been or is able to do « (auto-financing).

« 3. Auto-financing is possible only « provided that the tariffs cover at « least the expenses, including amortisations, that is to say amortisations calculated on the economic and not the « technical life and on the replacement « value.

« This condition is not however fulfilled with most railways. The amortisations are inadequate and even these « insufficient amortisations are not covered by the receipts. If the amortisations are insufficient, it is not because « the Administrations ignore the harmful consequences which will result. « Usually pressure is exerted by the « public authorities on the level of « amortisation or renewal charges with « a view to reducing the deficits to be « met by the State. This pressure « explains why the deficits are incompletely covered by the State and thus « cannot replace insufficient receipts. « What the State gives to the railways « so far as it meets the deficits is as a « rule too much to die and too little « to enable them to live.

« The reduction effected in the amortisation of railways is therefore all the « more difficult to justify since they « have legal obligations to operate and « carry which were imposed on them by « the States; instead of a reduction, « these obligations would rather justify « a strengthening of industrial amortisation in order to assure the continuity « of rail transportation, at least for « those lines which should be preserved « and for which other modes of transport should not be substituted.

« 4. The delay in the renewal and « modernisation of the investments « renders the technical and financial « position of the railways graver still « in face of competition.

« On the one hand this position makes

it an obstacle to acquire the means of modern technique whose use would allow the railways to increase their productivity and improve their services.

« On the other hand, it reduces the attraction of railway careers for the best among the young people.

« The result is a growing deficit which, in turn, causes an increasing pressure on the amortisations.

« 5. To escape from this vicious circle, the railways ought at least to be able to secure the funds needed for renewing and modernising their equipment by auto-financing. Recourse to loans can be justified where there is an increase in transport capacity or where productivity will be increased; the resultant financial charges should always be capable of being borne to a large extent. Auto-financing is only possible with adequate amortisations which are really covered by the receipts. To obtain a better financial equilibrium the following measures are essential :

« 1) A more efficient coordination must be carried out between the various means of transport in order to attain or to approach more closely conditions of competitive equality between them;

« 2) Railway tariff obligations must be made as flexible as possible wherever this practice is commercially possible;

« 3) The railway must be relieved of or indemnified for the costs resulting from the services imposed by the State and which favour the economy of the country as a whole; it must also be relieved of charges which are distinct from the operating needs.

« 6. As regards the accountancy technique of the amortisations and the presentation of the accounts, two things appear desirable : on the one hand, that the Railway Administrations or the public authorities in the event of a deficit renounce the practice of reducing the amortisations below the level materially justifiable and so giving a seemingly better appearance to the results; this reduction only serves to hide the real situation of the undertaking and to delay the needed measures of rehabilitation; on the other hand, the Railway Administrations should follow more closely commercial practice when calculating and presenting the amortisation accounts. Even if the special methods of the railways were identical materially with the conventional method of amortisation, which is only partly true, the adoption of this system would have the advantage of making the railway accounts clearer and more intelligible to business and political men not specialised in railway accountancy. Accounts which are difficult to understand give rise to suspicion. Now, the railways need the understanding and confidence of economic and political circles if they are to make good their claims which are set out in the summaries. »

5th SECTION. — Light railways and colonial railways.

QUESTION 9.

Experience obtained concerning the undulatory wear of rails.

— Damaging effects on the track, bridges, viaducts and tunnels, and on the rolling stock.

— Research into the causes of this kind of wear.

— Measures taken to avoid or to remedy it.

SUMMARIES.

I. Types and characteristics of undulatory wear of rails.

« 1. The different types of undulatory « wear can be classified into two groups :

« (*a*) Short wave undulatory wear, « the length of wave being 0.02 to « 0.08 m (0.08 to 3.1 in.) (most fre- « quently 0.043 m = 1.7 in.), and the « depth 0.12 mm (0.005 in.) (maximum « of 0.4 mm = 0.02 in.).

« (*b*) Long wave undulatory wear, « with which the length of wave varies « between 0.10 and 2 m (3.9 in. and « 6 ft. 7 in.), the depth being 5 mm « (0.2 in.) and over.

« 2. The commencement and deve- « lopment of undulatory wear are ex- « tremely complex phenomena which it « is very difficult to explain completely.

« The factors which can have an in- « fluence upon undulatory wear are « essentially :

« (*a*) the material and method of fa- « brication of the rails;

« (*b*) vibrations of the rail;

« (*c*) rail-wheel pressure and reac- « tions of the rail-wheel system under « the influence of the rolling stock;

« (*d*) oxidation due to friction;

« (*e*) the rolling stock;

« (*f*) the profile of the lines;

« (*g*) the kind of traffic;

« (*h*) the method of laying;

« (*i*) the rigidity of the bed.

« 3. The damage caused by undu- « latory wear is far from negligible and « is worth taking into consideration.

« Most of the railways have found « that on lines showing serious undu- « latory wear there is rapid general dete- « rioration of the track, loosening of the « rail fastenings, coachscrews and bolts, « ovalisation of the coachscrew holes. « loosening of the anti-creep devices, « disturbance of the bed, sleepers and « ballast.

« It can definitely be stated that more « rapid deterioration of the sleepers has « been noted in sections with serious « undulatory wear.

« 4. Again, loosening of bolts and « rivets in metal bridges had been ob- « served.

« 5. In general, the vibrations set up « by undulatory wear have a destructive « effect upon the various parts of the « rolling stock, but it is difficult to eva- « luate the extent of the damage caused.

II. Investigation into the causes of undulatory wear.

« 6. The composition of the metal plays an important part in the formation of undulatory wear. For example, Martin-Siemens rails are generally less subject to short wave undulatory wear than Thomas steel rails. A low nitrogen content improves the resistance to wear of rails manufactured by these two processes. Heat treated rails are more vulnerable to it than those which have not been so treated.

« 7. Rails which have been straightened upright during manufacture tend to show more marked undulatory wear.

« 8. Undulatory wear affects rails of all weight. Short wave undulatory wear may perhaps be more apparent with heavy rails.

« 9. In general, welded track shows no appreciable differences from the point of view of undulatory wear compared with ordinary non-welded track.

« 10. Certain observations make it possible to state that the use of check-rails results in a certain reduction in the depth of long wave undulatory wear.

« On the other hand, it appears that short wave undulatory wear disappears in line with level crossings equipped with check-rails.

« 11. The rail joints whether fish-plated or welded are disturbing influences, though to a different degree, but the data collected being contradictory, it is difficult to state whether they affect the formation or the development of the waves, or both.

« 12. No conclusive information has been supplied concerning the influence of the sleepers. No precise law can be formulated concerning the influence of the material used for the sleepers and the type of fastening. However, it has not been proved that the kind of sleepers and their method of laying have any effect on the formation and development of the waves.

« 13. It appears from an examination of the replies that a well laid layer of ballast is indicated to reduce undulatory wear. Some Administrations have found that there is an unfavourable influence on lines laid on an insufficiently elastic bed (particularly on rocky foundations).

« 14. The following factors favour the formation of undulatory wear : the unsprung weight of traction motors, small diameter wheels and uniformity of such diameters, braking by means of cast iron shoes, conicity of tyres, small spacing between driving axles.

« 15. The influence of the profile of the lines cannot be determined, the statements made being too contradictory. This also applies to the influence of the locality. It would, however, be interesting to pursue research particularly into the effect of tunnels and sections subject to considerable corrosion.

III. Steps taken to avoid undulatory wear or to remedy it.

« 16. No type of existing conventional fastening has yet been proved « to prevent undulatory wear. The introduction of fastenings with elastic « features is of too recent origin to permit of a conclusion being drawn with « regard to their effect.

« 17. Increasing the number of sleepers does not appear to have a beneficial effect on undulatory wear.

« 18. The practice of grinding rails « as an item of maintenance has been « adopted by many Administrations.

« 19. Heat treatment before laying, « by annealing, and either before laying « or after laying by blowlamp, is very « costly. Whereas the result of heat « treatment by annealing appears to « have uncertain effects, heat treatment « by blowlamp appears to be detrimental in the long run.

IV. Systematic research.

« 20. It has been found possible to « reproduce undulatory wear in the « laboratory. Researches and trials on « small sections have recently been « started by some Administrations, but « it is too early to formulate any final « conclusions. However, the following « indications have been obtained :

« — The chemical composition, heat « treatment and method of fabrication « have an effect upon the various types « of undulatory wear.

« — Certain rails, specially those « made of Thomas steel, show pronounced undulatory wear, whilst rails « made of Martin-Siemens steel with a « low nitrogen content remain almost « free.

« — The behaviour of rails made of « Thomas steel, manufactured with an « oxygen rich blast, is similar to that of « Martin-Siemens rails.

« — There appears to be a correlation between the increased stressing of « rails during the process of straightening during manufacture and the production of nascent corrugations.

« — In places where undulatory wear « exists, the period of natural vibrations « of the vehicles does not seem to correspond to vibrations which would be « produced by corrugations.

« — The method of laying has very « little effect upon undulatory wear.

« — Rubber pads have very little « effect on the development of undulatory wear. »

QUESTION 10.

In view of the development of light railways, what are the means to be adopted in order to reduce the operating costs of these railways and what are the resulting basic amendments ?

- **Delimitation of electrification and dieselisation in relation to the traffic, capital costs and operating costs.**
- **Co-ordination between rail and road :**
- **Possibilities of mixed rail-road vehicles and of specialised vehicles for rail or road.**
- **Principles to be followed in regard to investment, in order to improve the returns from the capital available for the transport industry.**

SUMMARIES.

« 1. The original concept of the term « light railways » has changed.

« The light railways studied here are lines which have problems different from those of main line systems on account of either the regional character of their traffic or the type of traffic requiring a simplified operation.

« 2. The light railways can be divided into the following categories :

« 1) The existing light railways in regions with recently developing economies.

« 2) The light railways in highly developed regions :

« (*a*) the small networks or isolated lines operated by private companies, generally under government control.

« (*b*) the secondary lines belonging to large national railways, which are State operated or controlled.

« 3. On the basis of the information supplied, the light railways constitute about 22 % of the total route mileage of the countries wherein they exist. It is thought however, that the true percentage is higher.

« During the last two decades, there has been very little extension of light railways, a fact which may be mainly attributed to the rapid development of the internal combustion engine in its application to road transport.

« 4. Due to the declining traffic, some light railways in category 2 had to be closed down. They lost 31 % of their mileage during the last two decades. In the aggregate, the original route mileage of the two categories 1 and 2 was reduced by about 25 %.

« The substitute services were provided by the road transport either run directly by the light railway companies themselves, by their subsidiaries or by private enterprise.

« 5. As some of the Railway Administrations do not maintain separate statistics for their light railways, and as many others who had, did not supply the required operating data, it is not possible to draw any broad conclusions regarding their performance.

« 6. From replies received, it appears that the following methods have been adopted to improve the financial position of the light railways :

« (*a*) the introduction of some elements of mechanization in laying and maintaining the permanent way;

« (*b*) progressive abandonment of steam traction and its replacement by Diesel traction and, in certain cases, by electric traction;

« (*c*) simplification of technical, commercial and operating methods;

« (*d*) doing away with the traditional subdivision of the staff into different departments (employees available for multiple duties), to ensure as far as practicable the continuous employment of personnel;

« (*e*) having traction units driven by one man (one-man cars);

« (*f*) exchange of rolling stock and various services between adjoining railways;

« *g*) simplification and perfecting of the transport documents;

« (*h*) progressive replacement of lines remaining unprofitable despite the application of various methods of rationalisation by road services.

« 7. The choice between dieselisation and electrification will vary with the local conditions. There is, in general, a preference for dieselisation.

« Electrification appears to be suitable for mountain lines, connections with systems that are already electrified and for regions where the price of fuel is particularly high.

« 8. The financial rehabilitation of the light railways would be considerably facilitated if they enjoyed greater liberty and more flexible tariffs, as is the case in general with independent road transport services.

« Some light railways can counter the road transport competition by participating in the road transport themselves.

« To place the railways in a position of parity and equity with the road transport services, it is necessary to impose and enforce certain technical, fiscal and administrative controls on the latter.

« 9. If the efforts made by the light railways to improve their position have proved fruitless or are considered insufficient, the lines showing the greatest deficits may be abandoned.

« It is not possible to give general criteria for the abandonment of these lines. It is necessary, however, to take into account, when evaluating the statistical and economic data, not only the traffic on this line but also the longer distance traffic which a line brings to the main railway network. In some cases, it is possible to allow a partial cancellation of services (closure or demolition of certain stations, abolition of passenger or freight services), or by abandoning intermediate lengths in certain lines where the service can be provided at the ends.

« A mixed solution can be considered in which motor transport would replace the railway services during slack hours, so that the line can be closed down for part of the day (stations, signalling, etc.).

« The substitute road services may be operated by the Railway Administration itself, by subsidiary companies or else by a private company under contract.

« In all cases, traffic extending over the rest of the network must be safeguarded in order to improve its financial position.

« In the case of abandonment, common agreement should be established between the railways, road and post office departments, with the consent of the local authorities, to enable the railway facilities (road beds, stations, lines of communication) to be used by the respective departments.

« 10. Should all efforts at financial rehabilitation fail and yet a railway line is required to be retained for political, strategic, geographical or climatic reasons, the Government or other public authorities concerned

« should take effective measures to « remedy the situation.

« 11. The grouping together of light « railways is a matter deserving consideration, so as to obtain a reduction « of general costs and a better utilisation of fixed installations and rolling « stock, so long as this is compatible « with greater flexibility and greater « freedom of action as regards the simplification of operating measures, and « the rationalisation of the services and « tariffs.

« 12. On some national railway systems the advisability of separating « within the system itself, the light railway lines from the main lines as « regards the regulations, operating and « accounts, is under consideration.

« 13. (*a*) In order to improve the economic conditions, the light railways « should emulate the road transport system by providing facilities such as « door to door services, greater flexibility « and simplification of relations with the « clients and by reducing to a minimum « the indirect and general costs and the « capital investments.

« (*b*) It is necessary for the national « or central governments to intervene to « achieve effectively rail-road co-ordination. Particularly it is their duty « to protect from harmful road competition, those lines which have to be « retained in operation.

« 14. In order to improve the returns « from the capital available for the « transport industry, the following principles should govern any investments :

« (*a*) to develop in extent and improve in quality the inland road network, in order to absorb the traffic « (passenger and freight) from the secondary lines to be closed down, « rather than make important great and « long motor arteries for heavy motor « transport, parallel to the main lines of « the main railways;

« (*b*) to orientate motor construction and road traffic standards towards « limiting the dimensions and loads of « road vehicles, so as to avoid the « development of large capacity motor « vehicles and trailers, whose presence « upon the roads is the cause of the inadequacy of the road network and « involves capital expenditure upon new « roads to a far greater extent than « would be needed for private vehicles « and vehicles of average tonnage.

« Such measures are within the competence of the Governments. »

NEW BOOKS AND PUBLICATIONS.

[**385** (02]

Directory of Railway Officials and Year Book, 1958-1959. London : Tothill Press Ltd., 33, Tothill Street, Westminster, S.W.1. — One volume of 596 pages (8 1/2 × 5 1/2 inches). Price : 40s. net.

The Directory of Railway Officials and Year Book, 1958-1959, reaches with the present volume its 64th. year of publication.

The first edition was compiled from official sources in 1895. The present edition containing 596 pages of text includes the general index and the personal index to railway officials, a noteworthy feature of the volume.

This edition should prove as valuable as its predecessors. A new section has been added giving details of Locomotive and Rolling Stock Suppliers throughout the world. In the statistical section, the list of Principal Electrically-Operated Railways has been amplified, particularly in regard to Great Britain, Belgium, Italy, Japan, Poland and Spain.

The entries regarding Poland and Roumania have been revised officially, and that of the U.S.S.R. Railways brought up to January 1958.

All other features have also been revised to date but have not needed drastic overhaul.

This very interesting publication will be greatly appreciated by all those concerned with railway matters.

A. U.

[**621** .3]

Lexikon der Hochfrequenz-, Nachrichten- und Elektrotechnik *(Dictionary of high frequency, telecommunications and industrial electricity techniques.)* — Four volumes, DIN C 6 format, of approximatively 800 pages each, with 200 figures and tables, bound in flexible imitation leather. — An additional volume containing an alphabetical index in English, French and Russian. — Published by Curt RINT (Porta-Verlag, 13*b*, Raisting am Ammersee). — (Price per volume : DM 28.75).

The techniques of high-frequency, telecommunications and industrial electricity in general, during the last few years, have undergone a considerable development.

The progress made in the first two in particular has become of such importance that ever greater specialisation is required of those technicians who deal with it.

Frequent examples show however the fragility of the boundary that it has been attempted to establish between the technique of « strong currents » and that of « weak currents », and it is now obvious that technicians devoted to one or other of these fields are no longer able to ignore other fields of activity in the domain of electricity, and on the contrary often have to decide whether it is opportune to modify profoundly the old conceptions.

Progress has been due to a knowledge of the results obtained by others as well as by individual research work, and it is essential to know the documents published in foreign languages, documents which form the basis of international exchanges on the intellectual plane.

The work published by C. Rint meets a double need and fills a gap.

One of the volumes is a technical dictionary giving the German, English, French and Russian names for some 20 000 items in connection with high frequency, telecommunications, and general industrial electricity techniques.

For this reason, it will be of particular interest to those whose work is based on foreign publications, translators, and those responsible for preparing the indices for technical libraries.

The reader with an adequate knowledge of German, will find that this work is also a very fully documented textbook, copiously illustrated with graphs and diagrams, explaining briefly and clearly the meaning of the terms used.

In this connection, it will be an invaluable aid both for the reader who merely wishes to extend or refresh his knowledge and for those who whilst reading a book or article dealing with some technical matter other than their own field, come across some idea, equation or proper name which is unfamiliar to them because it belongs to some other specialised branch.

Each of the numerous fields covered by the dictionary, whether it is a question of pure mathematics, cristallography, semiconductors, photometry or geophysics, etc., have been translated and commented upon by one or several experts.

This forms an invaluable guarantee as to the accuracy of all the definitions.

F. B.

MONTHLY BIBLIOGRAPHY OF RAILWAYS (1)

PUBLISHED UNDER THE SUPERVISION OF

P. GHILAIN,

General Secretary of the Permanent Commission of the International Railway Congress Association.

(NOVEMBER 1958)

[**016.** 385 (02]

I. — BOOKS.

In French.

1958 **621** .83

MACABREY (C.).

Le formulaire des engrenages. Traité pratique pour le calcul, le tracé et l'exécution des engrenages. 5^e^ édition.

Paris, Dunod, éditeur. Un volume (14 × 22 cm) de XV + 511 pages et 382 figures. (Prix : broché, 3 700 fr. fr.)

1958 **624** (06

Mémoires de l'Association Internationale des Ponts et Charpentes. Volume 17, Année 1957.

Zurich, Librairie Leemann. Un volume (17 × 24 cm) de 268 pages avec 157 figures.

1958 **62** (01

NACHTERGAL (A. & C.).

Aide-mémoire pratique de Résistance des Matériaux. 4^e^ édition.

Paris, Desforges, éditeur, 29, quai des Grands-Augustins. Un volume (16 × 25 cm) de 848 pages avec 1 403 figures. (Prix : 6 800 fr. fr.)

1958 **627** .82

Sixième Congrès International des Grands Barrages. (Septembre 1958). — N° 286, août 1958, de la Revue « Travaux ».

Paris (16^e^). Editions Science et Industrie, 6, avenue Pierre 1^er^ de Serbie. Un volume (23.5 × 31 cm) de 228 pages, abondamment illustré.

1958 **625** .6 (06

UNION INTERNATIONALE DES TRANSPORTS PUBLICS (U.I.T.P.).

Comptes rendus détaillés du XXXII^e^ Congrès International des Transports Publics. (Hambourg-Berlin 1957).

Bruxelles, Secrétariat Général de l'U.I.T.P., 18, Avenue de la Toison d'Or. Un volume (21.5 × 27.5 cm) de 200 pages, avec illustrations.

In German.

1958 **385**

BESSER (F.).

Kommentar zu den Eisenbahn-Bau-und-Betriebsordnungen. 5. erweiterte Auflage. Nachtrag II, bearbeitet von KAUNE und MITTMANN.

Frankfurt/M., Verkehrswissenschaftliche Lehrmittelgesellschaft m.b.H. 79 Seiten. (Preis : DM 5.—.)

1958 **691**

Beton-Kalender 1958.

Berlin, Verlag von Wilhelm Ernst & Sohn. 2 Bände (11 × 15 cm) mit 1 428 Abbildungen. *Band I* : XXX + 928 Seiten. *Band II* : XVI + 531 Seiten. (Preis : DM 19.20)

1958 **621** .33

KASPAR (C.A.)

Die Betriebs- und Tarifgestaltung der Elektrizitätswirtschaft und der Eisenbahnen als Träger öffentlicher Dienste. (Schweizerische Beiträge zur Verkehrswissenschaft : Heft 51.)

Verlag Stämpfli & Cie. (Preis : Sfr. 15.55.)

1958 **69**

Dipl.-Ing. H. RADEK.

Grundlagen des Stahlbaues.

Braunschweig, Berlin, Hamburg, München, Kiel, Darmstadt, Georg Westermann Verlag.

DIN C5. 258 Seiten mit 170 Abbildungen. (Preis : kart. DM 21.—; Leinen, DM 23.40.)

1958 **621** .3

Dr.-Ing. R. REINHARD.

Die Elektrotechnik. 5. erweiterte und verbesserte Auflage.

Leipzig, Fachverlag. 641 Seiten mit 1 051 Bildern, Format 16.2 × 22.9. (Preis : DM 18.50.)

1958 **621** .82

VOGELPOHL (G.).

Betriebssichere Gleitlager.

Berlin, Springer-Verlag. 315 Seiten mit 200 Abbildungen, 45 Zahlentafeln und 50 Berechnungsbeispielen. (Preis : Gln., DM 46.50.)

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(1) The numbers placed over the title of each book are those of the decimal classification proposed by the Railway Congress conjointly with the Office Bibliographique International, of Brussels, (See « Bibliographical Decimal Classification as applied to Railway Science », by L. WEISSENBRUCH, in the number for November 1897, of the *Bulletin of the International Railway Congress*, p. 1509).

In English.

1958 **621** .431 .72
Diesel Engine Catalog, 1958-59.
Edited by Rex W. WADMAN Los Angeles 46 : Diesel Progress.
One volume (13 1/2 × 10 1/2 in.) of 402 pages. (Price : 10 dollars.)

1958 **625** .251
FRINGS (H.R.).
Heat phenomena and industrial brakes calculations.
One brochure of 50 pages with diagrams, tables & figs.
Obtainable from R. H. Frings, 34, rue de l'Association, Bruxelles. (No price stated.)

1958 **621** .431 .72 (02
JONES (Morgan C.).
Diesel operator's guide.
One volume, 369 pages, illustrated., N.Y., McGraw-Hill 1956. (Price : $6.50.)

1958 **385** (02 (73)
LEWIS (Robert G.).
Handbook of American Railroads.
One volume, 251 pages 8 1/2 in. × 5 1/2 in., illustrated.
Published by Simmons — Boardman Books, New York.
Obtainable in Great Britain from Ian Allan Ltd., Hampton Court, Surrey. (Price 25 s.)

1953 **621** .13 (02
LUCAS (Walter A.).
100 years of steam locomotives.
One volume, 278 pages (11 3/4 in. × 8 5/8 in.), illustrated
Published by Simmons— Boardman Books, New York.
Obtainable in Great Britain from Ian Allan Ltd., Hampton Court, Surrey. (Price 25 s.)

1958 **691**
ORCHARD (D. F.).
Concrete technology. (Vol. 1).
London : Contractor's Record Limited, Lennox House, Norfolk Street, Strand, W.C. 2. (Price : 45 s.)

1958 **621** .131 .3
TUPLIN (W. A.).
Great Western Steam.
One volume (8 3/4 × 5 1/2 in.) of 193 pages + 17 p.p. plates.
London : George Allen & Unwin Ltd., 40, Museum Street, W.C. 1. (Price : 25 s.)

1958 **625** .28 (02
VAN METRE (T.W.) and VAN METRE (R.G.).
Trains, Tracks and Travel.
One volume, 432 pages 9 in. × 6 in., illustrated.
Published by Simmons — Boardman Books, New York.
Obtainable in Great Britain from Ian Allan Ltd., Hampton Court, Surrey. (Price 30 s.)

[**016.** 385 (05]

II. — PERIODICALS.

In French.

Annales des Ponts et Chaussées. (Paris.)

1958 **721** .4
Annales des Ponts et Chaussées, juillet-août, p. 429.
BOUTELOUP (P.). — Les **coupoles en maçonnerie non armée.** (75 pages & fig.)

1958 **721** .1
Annales des Ponts et Chaussées, juillet-août, p. 505.
KERISEL (J.). — Historique de la **mécanique des sols** en France jusqu'au XX^e siècle. (7 000 mots & fig.)

Bulletin de l'Association Suisse des Electriciens. (Zurich.)

1958 **621** .31
Bulletin de l'Assoc. Suisse des Electriciens, 30 août, p. 847.
de SENARCLENS (G.). — L'encyclopédie des **isolants électriques.** (2 500 mots & tableaux.)

Bulletin Sécheron. (Genève.)

1956 **621** .31
Bulletin Sécheron, n° 24 F, p. 3.
GERECKE (E.). — Le **redresseur scellé à vapeur de mercure et à atmosphère de gaz rare.** (8 000 mots & fig.)

1956 **621** .31
Bulletin Sécheron, n° 24 F, p. 25.
LUCHSINGER (W.). — Exemples d'**installations de redresseurs.** (18 000 mots & fig.)

1957 **621** .335
Bulletin Sécheron, n° 26 F, p. 2.
WERZ (H.). — La **transmission Sécheron par arbre à cardans et accouplements à lames.** (7 000 mots & fig.)

1957 **621** .335 (494)
Bulletin Sécheron, n° 26 F. p. 25.
HEGETSCHWEILER (H.). — Les **automotrices de 2 000 ch** des Chemins de fer Berne — Neuchâtel et Gürbetal — Berne — Schwarzenburg. (2 500 mots & fig.)

1957 **621** .335 (494)
Bulletin Sécheron, n° 26 F. p. 29.
GAIBROIS (P.). — Le **nouveau matériel roulant** du chemin de fer mixte à crémaillère et à adhérence de Martigny au Châtelard. (1 800 mots & fig.)

Bulletin de la Société Française des Electriciens. (Paris.)

1958 **656** .25 (0

Bulletin de la Société Française des Electriciens, mai, p. 306.

CHEVALLIER (M.A.). — **Transmission, technique des télécommunications.** (10 000 mots.)

Bulletin de la Société des Ingénieurs Civils de France. (Paris.)

1958 **621** .3

Bull. de la Soc. des Ing. Civils de France, mai-juin, p. 250.

BARON (P.). — La **lutte contre le bruit dans les installations électro-mécaniques.** (9 000 mots & fig.)

Bulletin de l'Office de Recherches et d'Essais. (O.R.E.). (Paris.)

1958 **621** .336

Bull. de l'O.R.E., juillet, p. 11.

L'**usure des pièces de frottement des pantographes et des fils de contact de la caténaire.** (1 800 mots & fig.)

1958 **625** .242

Bull. de l'O.R.E., juillet, p. 14.

Les études du **wagon-tombereau de l'avenir.** (2 000 mots & fig.)

1958 **625** .143 .3

Bull. de l'O.R.E., juillet, p. 18.

La **recherche des défauts des rails** par des procédés non destructifs. (3 000 mots.)

Bulletin technique de la Suisse Romande. (Lausanne.)

1958 **691**

Bulletin technique de la Suisse Romande, 2 août, p. 18.

CUÉNOD (J.-E.). — La **technique de la fabrication et du transport du béton** sur les chantiers moyens et petits. (3 500 mots & fig.)

Bulletin des Transports Internationaux par Chemins de fer. (Berne.)

1958 **656** .235 .6 (4)

Bull. des transp. intern. par ch. de fer, juillet, p. 186.

Le « **Tarif général européen pour les expéditions de détail** » contrevient-il à la C.I.M. ? (5 000 mots.)

1958 **656** .225 (73)

Bull. des transp. intern. par ch. de fer, août, p. 209.

Droit de l'expéditeur de choisir l'itinéraire, en trafic interétatique aux Etats-Unis d'Amérique. (1 500 mots.)

Bulletin de l'Union Internationale des Chemins de Fer. (Paris.)

1958 **385** (09 (3) & **385** .113 (3)

Bulletin de l'U.I.C., juillet/août, p. 234.

Les **chemins de fer en 1957.** *(Sixième partie).* (10 000 mots & tableaux.)

Economie et Technique des Transports. (Zurich.)

1958 **625** .215

Economie et Technique des Transports, nº 123, p. 53.

KNECHT (H.) & J.M. DEHALU. — **Essais d'endurance d'un châssis de bogie en acier moulé.** (3 700 mots & fig.)

1958 **621** .335 (494)

Economie et Technique des Transports, nº 123, p. 59.

HAURI (M.). — Les **nouvelles motrices légères** du Chemin de fer Berne-Loetschberg-Simplon. (7 000 mots & fig.)

Génie Civil. (Paris.)

1958 **621** .335 (44)

Génie Civil, nº 3476, 1er septembre, p. 345.

PAPAULT (R.). — Les **éléments automoteurs électriques** de la banlieue Sud-Est de Paris de la Société Nationale des Chemins de fer français. (6 000 mots & fig.)

Orientations Internationales. (Paris.)

1958 **656**

Orientations Internationales, mai-juin-juillet, p. 16.

Les **Transports dans le cadre du Marché Commun.** (3 000 mots.)

Rail et Traction. (Bruxelles.)

1958 **385** (06 .4 (493)

Rail et Traction, mai-juin, p. 95.

GUILLAUME (H.F.). — Le **parc des Chemins de fer Européens à l'Exposition de Bruxelles 1958.** (4 000 mots, tableaux & fig.)

Revue Générale de Mécanique. (Paris.)

1958 **698**

Revue Générale de Mécanique, mai, p. 252.

de JUNNEMANN (J.). — La **mise en peinture des machines dans l'industrie.** (1 500 mots & fig.)

1958 **669**

Revue Générale de Mécanique, mai p. 273.

LEJAY (H.). — Les **tôles plaquées d'aciers spéciaux.** (3 500 mots & figs.)

1958 **62** (01

Revue Générale de Mécanique, mai, p. 290.

FABRE (G.). — Essais mécaniques, physiques et chimiques des **matières plastiques.** (3 000 mots & fig.)

1958 **621** .8
Revue Générale de Mécanique, juin, p. 295.
PATIN (P.). — Les **transmissions hydrauliques.** *(A suivre.)* (3 000 mots & fig.)

Revue Juridique et Economique du Sud-Ouest. (Bordeaux.)

1958 **625** .6 (44)
Revue juridique et économique du Sud-Ouest, n° 3, p. 399.
Le **Réseau ferré départemental des Landes.** (V.F.L.). (20 000 mots & carte.)

Revue de l'Union Internationale des Transports Publics. (Bruxelles.)

1958 **656** .222 .5
Revue de l'Union Intern. des Transp. Publics, n° 1, p. 17.
BURNELL (J.B.). — **Pünktlichkeit, Haupterfordernis der Fahrgastbeförderung.** (5 000 Wörter.)

1958 **625** .42
Revue de l'Union Intern. des Transp. Publics, n° 1, p. 31.
PATRASSI (A.). — Considérations à propos des **métropolitains.** (10 000 mots & fig.)

La Vie du Rail. (Paris.)

1958 **625** .232 (44)
La Vie du Rail, 27 juillet, p. 21.
Voitures-couchettes de la S.N.C.F. (600 mots & fig.)

1958 **385** (09 (44)
La Vie du Rail, 3 août, p. 3.
Histoire de la Compagnie Française des wagons-buffets. (3 500 mots & fig.)

1958 **656** .254 (65)
La Vie du Rail, 17 août, p. 3.
Télécommunications aux Chemins de fer Algériens. (1 000 mots & fig.)

1958 **621** .3 : **656** .25
La Vie du Rail, 31 août, p. 15.
L'électronique au service du chemin de fer. (2 000 mots & fig.)

In German.

Die Bundesbahn. (Darmstadt und Köln.)

1958 **385** (06.4 (493)
Die Bundesbahn, Sonderdruck, S. 9.
WENDLER (K.). — Die **UIC unter dem fünfzackigen Stern von Brüssel.** (5 000 Wörter & Abb.)

1958 **656** .2
Die Bundesbahn, Sonderdruck, S. 20.
MAIER-SCHOEN (A.). — Die **Produktivität der Eisenbahnen.** (4 000 Wörter.)

1958 **656** .223 .1 (43)
Die Bundesbahn, Nr. 13, Juli, S. 724.
MÜNDEMANN (W.). — Der **Reisezugwagendienst** bei der Deutschen Bundesbahn. (3 000 Wörter & Bildern.)

1958 **656** .222 .5 (492)
Die Bundesbahn, Nr 13, Juli, S. 739.
de GRAAFF (W.J.). — Das **Fahrplansystem** der Niederländischen Eisenbahnen. (3 500 Wörter & Abb.)

1958 **385** .11 (43)
Die Bundesbahn, Nr. 14, Juli, S. 755.
RINGLEB (W.). — **Die Deutsche Bundesbahn und der Kapitalmarkt.** (2 500 Wörter.)

1958 **656** .286
Die Bundesbahn, Nr. 14, Juli, S. 759.
KRAFT (E.). — Der Beweis des ersten Anscheins. — **Unfälle beim Ein- und Aussteigen bei haltenden Zügen.** (4 000 Wörter.)

1958 **621** .33 (43)
Die Bundesbahn, Nr 14, Juli, S. 763.
KELLER (M.). — Das **elektrische Streckennetz der Deutschen Bundesbahn** zum Fahrplanwechsel 1958. (2 500 Wörter & Abb.)

1958 **656** .2 (43)
Die Bundesbahn, Nr. 14. Juli, S. 772.
NAGEL (G.). — Der Einsatz von Kleinlok und V 60 zur **Beschleunigung des Nahverkehrs** und zur **Verbesserung der Bedienung der Kunden der DB.** (5 000 Wörter & Abb.)

Deutsche Eisenbahntechnik. (Berlin.)

1958 **621** .138
Deutsche Eisenbahntechnik, Juli, S. 323.
MATTHES (S.). — Über die Ermittlung von Kenngrössen für die **Beurteilung der Lokomotivunterhaltung.** (9 000 Wörter & Abb.)

1958 **625** .2
Deutsche Eisenbahntechnik, Juli, S. 333.
BÜTTNER (S.) und GRUSS (A.). — **Auswahl der zweckmässigsten Konstruktion eines Schienenfahrzeuges** mit Hilfe einer Punktbewertung. (3 500 Wörter & Abb.)

1958 **625** .244
Deutsche Eisenbahntechnik, Juli, S. 337.
BECKER (J.). — **Umbaumöglichkeiten eines Eiskühlwagens in einen Maschinenkühlwagen.** *(Fortsetzung.)* (6 000 Wörter & Tafeln.)

1958 **621** .438
Deutsche Eisenbahntechnik, Juli, S. 343.
Technisch-wirtschaftlicher Nutzeffekt bei **Verwendung von Gasturbinenlokomotiven.** (2 000 Wörter & Tafeln.)

1958 **656** .235
Deutsche Eisenbahntechnik, Juli, S. 345; August, S. 407.
WIDERSTEIN (K.). — Die **Entwicklung des Gütertarifs** bei der Deutschen Bundesbahn. (15 000 Wörter & Abb.)

1958 **656** .254
Deutsche Eisenbahntechnik, Juli, S. 353.
BECHSTEIN (V.). — Die Probleme der **Warnzeitangleichung an automatischen Überwegsicherungsanlagen.** (10 000 Wörter & Abb.)

1958 **625** .24
Deutsche Eisenbahntechnik, August, S. 369.
Die wirtschaftlichste **Güterwagengrösse.** (1 000 Wörter & Tafel.)

1958 **656** .211 .5
Deutsche Eisenbahntechnik, August, S. 371.
GALL (W.), BORYS (O.A.) & KÄSTNER (G.). — Zur Berechnung der für einen Bahnhof notwendigen **Bahnsteigkanten.** (2 000 Wörter & Abb.)

1958 **621** .335
Deutsche Eisenbahntechnik, August, S. 375.
KREUTER (E.). — Die **leistungsfähigste Gleichstrom-Industrielokomotive** der Welt. (5 000 Wörter & Abb.)

1958 **625** .2
Deutsche Eisenbahntechnik, August, S. 384.
DÜCK (W.). — **Graphische Bestimmung der Drehgestellausschläge im Bogenlauf.** (600 Wörter & Abb.)

1958 **621** .131
Deutsche Eisenbahntechnik, August, S. 385.
PRUSSAK (H.). — **Dynamische Kennlinien für Dampflokomotiven.** (5 000 Wörter & Abb.)

1958 **625** .245 (43)
Deutsche Eisenbahntechnik, August, S. 396.
SCHILLER (K.). — Der neue **Doppelstockgüterwagen** der Deutschen Reichsbahn. (2 000 Wörter & Abb.)

1958 **625** .25
Deutsche Eisenbahntechnik, August, S. 399.
MEHLMANN (H.). — Der **Einfluss der Bremsdurchschlagsgeschwindigkeit auf die Geschwindigkeitssteigerung** im Eisenbahnverkehr. (2 000 Wörter & Abb.)

Der Eisenbahningenieur. (Frankfurt-Main.)

1958 **625** .14 (485)
Der Eisenbahningenieur, August, S. 226.
Der **Oberbau bei den Schwedischen Eisenbahnen.** (2 000 Wörter & Abb.)

1958 **625** .236 (73)
Der Eisenbahningenieur, August, S. 229.
SCHRÖDER (O.). — **Reinigung der Reisezugwagen** in den USA. (10 000 Wörter & Abb.)

1958 **621** .138
Der Eisenbahningenieur, August, S. 239.
DÖNNEBRINK (J.). — **Reinigung und Pflege der Dampflokomotiven mit** neuzeitlichen Reinigungs- Pflegemitteln und Geräten. (2 000 Wörter & Abb.)

1958 **625** .123
Der Eisenbahningenieur, August, S. 241.
WEGENER (F.). — **Rutschungen an Böschungen** — Unterhaltung und Entwässerung. (1 200 Wörter & Abb.)

1958 **691**
Der Eisenbahningenieur, September, S. 253.
BRUX (G.). — **Neuartiger Unterwasserbeton.** Anwendung des COLCRETE-Verfahrens. (3 000 Wörter & Abb.)

1958 **656** .212 .6
Der Eisenbahningenieur, September, S. 257.
KAHMANN (U.). — **Ein- und aussetzbare Gleisbrücke für Umladeanlagen mittels Gabelstapler.** (600 Wörter & Abb.)

1958 **656** .212 .6
Der Eisenbahningenieur, September, S. 258.
ZEMKE (U.). — Befestigung der Fahrbahn bei **Ladestrassen und Rampen.** (1 500 Wörter & Abb.)

E.T.R. — Eisenbahntechnische Rundschau. (Köln-Darmstadt.)

1958 **725** .31 (43)
E.T.R. — Juli, S. 271.
FACKLER (K.). — **Neuer Hochbau** im Bezirk der Bundesbahndirektion München. (11 000 Wörter & Abb.)

1958 **621** .133 .1 (43)
E.T.R. — Juli, S. 293.
KOTZOTT (K.). — **Schlackenscheideanlagen und ihre Wirtschaftlichkeit** am Beispiel der Anlage Hamburg-Eidelstedt erläutert. (4 000 Wörter & Abb.)

1958 **656** .2
E.T.R. — Juli, S. 299.
DOBMAIER (A.). — **Eisenbahn und Verkehrsplanung.** (6 000 Wörter & Abb.)

Elektrische Bahnen. (München.)

1958 **621** .335 (43)
Elektrische Bahnen, Heft 7, S. 145.
SANDNER (F.) und BRAUER (A.). — Die **elektrische Ausrüstung der schweren Güterzuglokomotive Baureihe** E 50 der Deutschen Bundesbahn. *(Fortsetzung folgt.)* (9 000 Wörter & Abb.)

1958 **621** .332
Elektrische Bahnen, Heft 7, S. 157.
KAMMERER (A.). — Betrachtungen über die **Stabilität von Wechselstromübertragungen.** (5 000 Wörter & Abb.)

1958 **621** .33 (492 + 493)
Elektrische Bahnen, Heft 7, S. 164.
BAEYENS (F.). — Die **Elektrisierung der Strecke Antwerpen-Roosendaal** und die neuen Triebwagen der Belgischen und Niederländischen Eisenbahnen. (1 500 Wörter & Abb.)

Elektrotechnik und Maschinenbau. (Wien.)

1958 **621** .31
Elektrotechnik und Maschinenbau, 1 August, S. 464.
LOEBNER (F.). — Die bei **Überlastung thermisch hochbeanspruchter Maschinenwicklungen zu erwartenden Übertemperaturen.** (2 500 Wörter & Abb.)

1958 **621 .31**

Elektrotechnik und Maschinenbau, 1. September, S. 481.

WAGNER (L.). — **Remanenz-Schütze.** (3 000 Wörter & Abb.)

1958 **621 .31**

Elektrotechnik und Maschinenbau, 1. September, S. 485.

FRENTZ (H.-J.). — Ein Berechnungsschema für die **Lebensdauer elektrischer Isolierstoffe** bei Beanspruchung durch periodische Temperaturspiele. (1 800 Wörter & Abb.)

Glasers Annalen. (Berlin.)

1958 **385** (06 .4

Glasers Annalen, Juli, S. 224.

HOFFMEISTER (K.). — **Moderne Schienenfahrzeuge auf der Weltausstellung Brüssel 1958.** (10 000 Wörter, Tafeln & Abb.)

1958 **625** .22

Glasers Annalen, Juli, S. 248.

MIELICH (A.). — Die **Breitenbemessung langer Eisenbahnfahrzeuge**. (1 500 Wörter & Abb.)

1958 **625** .2 (0

Glasers Annalen, Juli, S. 251.

SCHNEIDER (V.). — Auffassungen über die **Belastbarkeit von Eisenbahn-Wagenradsätzen** seit August Wöhler. (3 000 Wörter & Abb.)

Internationales Archiv für Verkehrswesen. (Mainz.)

1958 **656** (494)

Internat. Archiv für Verkehrswesen, Heft 13, Juli, S. 270.

Problem Schiene und Strasse auch in der Schweiz. (1 200 Wörter.)

Signal und Draht. (Frankfurt am Main.)

1958 **656** .257 (43)

Signal und Draht, August, S. 142.

GRANDRATH (F.). — **Gleisbildstellwerke** in Düsseldorf Hbf. und viergleisiger Ausbau Düsseldorf-Duisburg. (1 600 Wörter & Abb.)

1958 **656** .254 (4)

Signal und Draht, August, S. 147.

MAKALA (A.). — Die **Fernsprechwähltechnik** bei den europäischen Eisenbahnen. *(Schluss folgt.)* (1 600 Wörter & Tafeln.)

Wissenschaftliche Zeitschrift der Hochschule für Verkehrswesen Dresden. (Dresden.)

1958 **656** .25

Wissenschaftliche Zeitschrift der Hochschule für Verkehrswesen Dresden. Heft 6, S. 809.

POTTHOFF (G.). — Verträgliche Fahrwege. (2 000 Wörter & Abb.)

1958 **656** .222 .5

Wissenschaftliche Zeitschrift der Hochschule für Verkehrswesen Dresden. Heft 6, S. 815.

POTTHOFF (G.). — **Die Bündelung der Züge im Fahrplan.** (3 000 Wörter & Tafeln)

1958 **621** .8

Wissenschaftliche Zeitschrift der Hochschule für Verkehrswesen Dresden. Heft 6, S. 841.

JENTSCH (O.). — **Beitrag zur Frage hydraulischer Kraftübertragung.** (3 500 Wörter & Abb.)

1958 **656** .256 .3

Wissenschaftliche Zeitschrift der Hochschule für Verkehrswesen Dresden, Heft 6, S. 857.

FISCHER (K.). — **Probleme des Selbstblocks** — Vorschlag für ein neues System. (9 000 Wörter & Abb.)

In English.

BTH Activities. (Rugby.)

1958 **621** .431 .72(42).

BTH Activities, May/June, p. 115.

800-HP Diesel-electric locomotives. (3 200 words & figs.)

Bulletin, American Railway Engineering Association. (Chicago.)

1958 **691**

Bulletin, American Railway Engineering Association June/July, p. 1.

SLUTTER (R.G.) and EKBERG (C.E.). — **Static and fatigue tests on prestressed concrete railway slabs.** (48 pages, illustrated.)

1958 **625**.172 (73)

Bulletin, American Railway Engineering Association, June/July, p. 1.

Tie renewals and costs per mile of maintained track. (300 words & tables.)

Electrical Engineering. (New York.)

1958 **621** .33 (73)

Electrical Engineering, September, p. 797.

ROSS (B.A.). — **Trends in railway electrification.** (2 000 words & figs.)

The Engineer. (London.)

1958 **621** .431 .72 (42)

The Engineer, July 11, p. 60.

NOCK (O.S.). — **Performance and efficiency tests on the 3 300 HP « Deltic » locomotive.** (2 500 words, figs. & charts.)

1958 **624** (0 (42)

The Engineer, July 18, p. 92.

Erection study of prestressed bridges. (700 words & figs.)

1958 656 .211 .7 (493)
The Engineer, July 18, p. 98.
TRIPP (G.W.). — **Car Ferry M.V. « Artevelde ».**

1958 621 .431 .72 (42)
The Engineer, July 18, p. 105.
Diesel-hydraulic traction. (800 words & figs.)

Engineering. (London.)

1958 625 .216 (42)
Engineering, June 27, p. 811.
Level crossings in Great Britain. (2 000 words & figs.)

1958 624 .63 (42)
Engineering, June 27, p. 813.
Pelham bridge, Lincoln. — City's worst level crossing eliminated. (2 500 words, plans & figs.)

1958 625 .214
Engineering, July 11, p. 59.
HALTON (J.H.). — **Lubrication of plain bearings.** Applicability of Reynold's hydrodynamic theory. (2 500 words.)

1958 651 & 656 .22
Engineering, July 18, p. 87.
Computing train timetables. (1 000 words & figs.)

1958 621 .431 .72 (42)
Engineering, July 25, p. 123.
Diesel-hydraulic locomotive of 2 200 HP. (1 200 words & figs.)

Indian Railway Technical Bulletin. (Lucknow.)

1958 621 .33 (54) & 656 .25 (54)
Indian Railway Technical Bulletin, May, p. 76.
GUPTA (K.K.). — **Telecommunication and signalling problems of high voltage standard frequency electric traction.** (5 000 words & figs.)

Proceedings, The Institution of Civil Engineers. (London.)

1958 691
Proceedings, The Institution of Civil Engineers. Vol. 10, August, p. 473.
CLAVEL BATE (S.C.). — **The relative merits of plain and deformed wires in prestressed concrete beams under static and repeated loading.** (30 pages, illustrated.)

Journal, The Institution of Locomotive Engineers. (London.)

1958 621 .33 (485)
Journal, The Institution of Locomotive Engineers, Vol. 48 *(Part 1)*, No. 261, p. 20.
UPMARK (E.). — **Development of electric traction in Sweden and its influence on rolling stock.** (24 pages, illustrated.)

1958 621 .431 .72 (73)
Journal, The Institution of Locomotive Engineers, Vol. 48 *(Part 1)*, No. 261, p. 45.
McLEAN (H.G.). — **American experience as a guide to main-line Diesel locomotive applications overseas.** (94 pages, illustrated.)

Journal of the Institute of Transport. (London.)

1958 621 .431 .72 (41)
Journal of the Institute of Transport. July, p. 345.
COURTNEY (T.C.). — **The change-over to diesel traction on Irish railways.** (5 000 words.)

1958 656 .2 (42)
Journal of the Institute of Transport. July, p. 353.
ROBERTSON (General Sir Brian). — **The organisation of transport.** (4 500 words.)

1958 656 .2
Journal of the Institute of Transport. July, p. 359.
Railway management. (5 000 words.)

The Locomotive. (London.)

1958 621 .132 .1 (42)
The Locomotive, July, p. 131.
NOCK (O.S.). — **The locomotives of Sir William Stanier-III.** (3 500 words & figs.)

1958 621 .431 .72 (42)
The Locomotive, August, p. 142.
New rolling stock for British Railways. (1 000 words & figs.)

1958 621 .431 .72 (42)
The Locomotive, August, p. 144.
A 2 200 H P diesel-hydraulic locomotive for British Railways. (2 600 words & figs.)

1958 621 .431 .72 (42)
The Locomotive, August, p. 147.
A 1 160 H.P. diesel-electric locomotive for British Railways. (4 000 words & figs.)

Modern Railroads. (Chicago.)

1958 625 .172 (73)
Modern Railroads, May, p. 127.
Machines improve Seaboard roadway. (1 000 words and figs.)

1958 656 .25 (73)
Modern Railroads. May, p. 147.
Leader in traffic control. (1 200 words and figs.)

1958 656 .25 (73)
Modern Railroads. May, p. 157.
Seaboard's « electronic era ». (1 200 words & figs.)

1958 385 (061 .4 (73)
Modern Railroads. June, p. 95.
More AAR research on the way. (2 500 words & figs.)

Modern Transport. (London.)

1958 **621** .431 .72 (42)
Modern Transport, June 14, p. 10.
German railbuses. — Eastern Region gets five **W.M.D. units.** (600 words & figs.)

1958 **385** .3 (08 (42)
Modern Transport, June 28, p. 3.
British transport in 1957. — B.T.C. report and accounts. (1 200 words.)

1958 **621** .431 .72 (42)
Modern Transport, July 19, p. 3; July 26, p. 5.
Swindon-built main-line diesel locomotive. (3 300 words & figs.)

1958 **625** .285 (42)
Modern Transport, July 26, p. 15.
Metropolitan Line stock. (400 words & figs.)

The Oil Engine. (London.)

1958 **621** .431 .72 (42)
The Oil Engine, July, p. 80.
Opinions and comments — B.T.C. chairman's views on oil-engined traction. (800 words & figs.)

1958 **621** .431 .72 (41)
The Oil Engine, July, p. 101.
Oil engines' advantages for the C.I.E. system. (2 800 words & figs.)

1958 **621** .431 .72 (54)
The Oil Engine, July, p. 103.
400-H.P. railcars on Indian State Railways. (800 words & figs.)

Railway Age. (New York.)

1958 **621** .338 (73)
Railway Age, June 30, p. 18.
PRR's Pioneer III is ready to go. (2 500 words & figs.)

1958 **625** .234 (73)
Railway Age, July 14, p. 12.
H & M gets air-conditioned cars. (1 200 words & figs.)

1958 **656** .212 (73)
Railway Age, July 14, p. 21.
Yard automation pays off. (2 600 words & figs.)

1958 **656** .212 (73)
Railway Age, July 21, p. 16.
Communications speed yard work. (1 600 words & figs.)

1958 **656** .32 (73)
Railway Age, July 21, p. 18.
PRR bridge will set record. (1 500 words & figs.)

Railway Engineering. (Cape Town.)

1958 **621** .132 .1 (68)
Railway Engineering, June, p. 24.
Versatile Garratt locomotive is the workhorse of Africa's railways. (2 200 words & figs.)

1958 **625** .245 (68)
Railway Engineering, June, p. 33.
New girder wagon was designed for awkward loads up to 150 tons.

1958 **621** .431 .72 (68)
Railway Engineering, July, p. 20.
Universal type Bo-Bo units are placed in line service in the Transvaal. (1 400 words & figs.)

1958 **621** .431 .72 (44)
Railway Engineering, July, p. 26.
Traction Diesel engines show little wear after long service in S.N.C.F. locos. (900 words & figs.)

The Railway Gazette. (London.)

1958 **385** (42)
The Railway Gazette, July 4, p. 11.
British Transport Commission results for 1957. (3 300 words & charts.)

1958 **621** .33 (43)
The Railway Gazette, July 4, p. 17.
Development of electric traction in Germany. (1 500 words, figs. and plans.)

1958 **621** .33 (46)
The Railway Gazette, July 4, p. 20.
Extension of electrification around Barcelona. (500 words & figs.)

1958 **625** .173 (94)
The Railway Gazette, July 11, p. 43.
Reconstruction of station and bridges at Richmond Melbourne. (1 500 words & figs.)

1958 **625** .171 (54)
The Railway Gazette, July 11, p. 47.
Self-propelled tower inspection cars. (1 500 words & figs.)

1958 **625** .143 .5
The Railway Gazette, July 18, p. 70.
Resilient pads on permanent way. (2 600 words & figs.)

1958 **621** .431 .72 (42)
The Railway Gazette, July 18, p. 75.
Swindon-built type « 4 » diesel-hydraulic locomotives. (1 800 words & figs.)

Diesel Railway Traction. (London.)

1958 **621** .431 .72 (6)
Diesel Railway Traction, June, p. 225.
Locomotives for Mozambique. (900 words & figs.)

958 621 .431 .72 (42)

sel Railway Traction, June, p. 228.
he Deltic locomotive on test. (2 500 words & figs.)

1958 621 .431 .72 (47)

sel Railway Traction, July, p. 251.
pecial dual-purpose locomotives. (3 500 words & figs.)

1958 621 .431 .72

esel Railway Traction, July, p. 259.
Dual fluidrive transmission. (1 800 words & figs.)

1958 621 .431 .72 (45)

esel Railway Traction, July, p. 263.
Italian large diesel-hydraulic locomotive. (700 words, s and plans.)

ailway Locomotives and Cars. (New York.)

1958 625 .234 (73)

ailway Locomotives and Cars, Julj, p. 38.
First air-conditioned transit car fleet. (1 400 words & gs.)

Railway Steel Topics. (Sheffield.)

1958 669 .1

ailway Steel Topics, No. 3, Vol 4, p. 4.
RYAN (C.F.). — Steel in relation to the **British ailways modernisation plan.** (4 000 words & figs.)

1958 625 .142 .4

ailway Steel Topics, No. 3, Vol 4, p. 13.
LEE (Donovan H.). — **Concrete sleepers.** (6 000 ords & figs.)

1958 625 .143 .5

ailway Steel Topics, No. 3, Vol 4, p. 24.
VALENTA (W.L.). and BABB (A.S.). — **Fastenings or flat bottomed rail.** (3 500 words & figs.)

1958 625 .143 .1

ailway Steel Topics, No. 3, Vol 4, p. 36.
BABB (A.S.) and HESELWOOD (W.C.). — **Some xperimental methods of investigating rail section design.** 5 000 words & figs.)

Railway Signaling and Communications. (New York.)

1958 625 .162 (73)

Railway Signaling and Communications, June, p. 19.
Crossing protection program saves 59 %. (2 500 words & figs.)

1958 656 .254 (73)

Railway Signaling and Communications, June, p. 27.
Chicago transit tests train-phone. (800 words & figs.)

1958 656 .21 (73)

Railway Signaling and Communications, June, p. 28.
How to save time... when trains are entering yards. (2 000 words & figs.)

In Spanish.

Ferrocarriles y Tranvias. (Madrid.)

1958 621 .332 (460)

Ferrocarriles y Tranvias, Vol 24-XII, N° 280, p. 326.
PEREZ MORALES (G.). — **Nueva cateneria tipo Renfe.** (6 000 palabras & figs.)

Revista de Ciencia Aplicada. (Madrid.)

1958 531

Revista de Ciencia Aplicada, julio-agosto, p. 304.
PAJARES DIAZ (E.). — **Taquímetro indicador de velocidades medias.** (6 000 palabras & fig.)

Revista de Obras Públicas. (Madrid.)

1958 656 .2

Revista de Obras Públicas, Agosto, p. 455.
DE INZA TUDANCA (C.). — **El tráfico ferroviario y algunas de sus relaciones con la economía general del país.** (6 000 palabras, cuadros y graficos.)

In Italian.

Giornale del Genio Civile. (Roma.)

1958 691

Giornale del Genio Civile, maggio, p. 287.
LEVI (F.). — **I lavori del Comitato Europeo del Cemento armato.** (5 000 parole & fig.)

Ingegneria Ferroviaria. (Roma.)

1958 656 (4)

Ingegneria Ferroviaria, luglio-agosto, p. 643.
DELLA PORTA (G.). — **I trasporti nella Communità Europea.** (3 500 parole.)

1958 725 .3 (45)

Ingegneria Ferroviaria, luglio-agosto, p. 665.
GOTELLI (R.). — Copertura di una parte del piazzale viaggiatori di Genova P.P. come **singolare soluzione di un problema ferroviario e stradale.** (1 500 parole & fig.)

1958 625 .151

Ingegneria Ferroviaria, luglio-agosto, p. 669.
CONTALDI (G.). — La **manovra dei nuovi deviatoi elastici** degli armamenti pesanti da 49 e 60 kg/ml. (4 000 parole & fig.)

1958 656 .254 (45)

Ingegneria Ferroviaria, luglio-agosto, p. 681.
FALOCI (A.) & DAL MONTE (G.). — **Impianti telefonici con teleselezione** delle F.S. *(Continua.)* (6 000 parole & fig.)

1958 625 .285 (45)
Ingegneria Ferroviaria, luglio-agosto, p. 692.
MELANI (F.). — **Le nuove automotrici termiche gruppo ALn 773** e i rimorchi per dette gruppo Ln 664. (4 000 parole & fig.)

1958 625 .245 (45)
Ingegneria Ferroviaria, luglio-agosto, p. 721.
SANESI (A.). — **Nuovi mezzi di recupero F.S.** per materiale ferroviario. (1 600 parole & fig.)

In Netherlands.

De Ingenieur. (Den Haag.)

1958 **624** (492)
De Ingenieur, nr 33, 15 augustus, p. 85.
VAN ZUTPHEN (J.). — **Onderzoekingen aan een spoorwegviaduct** te Rotterdam. (4 000 woorden & fig.)

1958 **691**
De Ingenieur, nr 33, 15 augustus, p. 90.
VAN SCHAIK ZILLESEN (G.). — Het **bekist lassen van betonijzer.** (1 500 woorden & fig.)

1958 **621** .8
De Ingenieur, nr 35, 29 augustus, p. W. 115.
ROOZEVELD VAN DER VEN (J.F.). — **Planetaire tandwielaandrijvingen.** (3 000 woorden & fig.)

1958 **691**
De Ingenieur, nr 36, 5 september, p. B. 211.
OPHORST (R.C.). — **Experimenteel betononderzoek.** (3 000 woorden.)

Spoor- en Tramwegen. (Den Haag.)

1958 **385** .113 (492)
Spoor- en Tramwegen, nr 16, 31 juli, p. 255.
De Nederlandsche Spoorwegen in 1957. (2 800 woorden.)

1958 **385** (4 + 73)
Spoor- en Tramwegen, nr 16, 31 juli, p. 257.
LANDSKROON (F.P.A.). — De **spoorwegen in Europa, de Verenigde Staten en de U.S.S.R.** (1 500 woorden.)

1958 **625** .232
Spoor- en Tramwegen, nr 17, 14 augustus, p. 263.
HARMSEN (B.T.). — **Postrijtuigen en hun omloop.** (3 500 woorden & fig.)

1958 **621** .335 (44)
Spoor- en Tramwegen, nr 17, 14 augustus, p. 269.
VAN DEN DOOL (W.H.). — **Elektrische locomotieven BB 9 200** van de S.N.C.F. (1 000 woorden & fig.)

1958 **656** (4)
Spoor- en Tramwegen, nr 17, 14 augustus, p. 272.
LANDSKROON (F.P.A.). — De **coördinatie van het Europese vervoer.** IV. (2 000 woorden.)

1958 **656** .212 .5 (43)
Spoor- en Tramwegen, nr 18, 28 augustus, p. 279.
VAN DER SAR (F.). — Het **heuvelstation Gremberg.** (3 000 woorden & fig.)

1958 **625** .233 (492
Spoor- en Tramwegen, nr 18, 28 augustus, p. 285.
BECHTOLD (Th.). — **De verlichting in onze Neder-landse treinen.** (1 500 woorden & fig.)

1958 **656** .22
Spoor- en Tramwegen, nr 18, 28 augustus, p. 289.
VAN BIJNEN (J.). — **Piggyback.** (1 000 woorden & fig.)

In Portuguese.

Gazeta dos Caminhos de Ferro. (Lisboa.)

1958 **385** (09 .3 (469)
Gazeta dos Caminhos de Ferro, nº 1696, 16 de Agosto, p. 359.
DE QUADROS ABRAGÃO (F.). — **No Centenario dos Caminhos de Ferro em Portugal.** Algumas notas sobre a sua historia. (2 000 palavras.)

In Swedish. (= 439 .71.)

Järvägs - Teknik. (Stockholm.)

1958 **656** .212 .5 (:439 .71)
Järnvägs-Teknik, No. 3, p. 55.
EKLUND (P.). — **Braking problems in the marshalling yards.** (5 000 words & figs.)

In Czech. (= 91.886.)

Inženýrské Stavby. (Praha.)

1958 **721** .9 (= 91 .886)
Inženýrské Stavby, August 21, p. 421.
TREFNÝ (P.). — **Steel-concrete composite construction of a railway bridge.** (1 000 words & figs.)

Železnični Technika. (Praha.)

1958 **656** .254 (: 91 .886)
Železnični Technika, No. 5, p. 113.
POUPĚ (O.). — **Light signals for level crossings.** (3 500 words & figs.)

1958 **621** .392 : **625** .143 (: 91.886)
Železnični Technika, Nos. 7/8, p. 175.
VAVERKA (J.). — **Technology of welding rails without joints.** (2 500 words & figs.)

1958 **625** .143 .3 (= 91 .886)
Železnični Technika, Nos. 7/8, p. 183.
KASÍK (G.). — **Train grinding rails,** Scheuchze system. (1 500 words & figs.)

1958 **621** .133 .7 (457) (= 91 .886)
Železnični Technika, Nos. 7/8, p. 190.
HANAK (F.). — **Treatment of the feeding water fo locomotives on the Czechoslovakian Railways.** (2 00 words & figs.)

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